A Naturalist in Brazil

KONRAD GUENTHER

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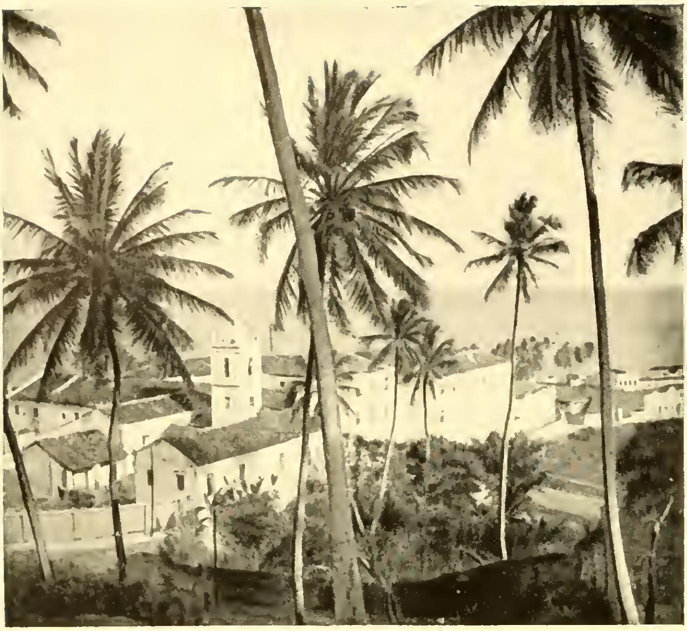

THE FRANCISCAN MONASTERY, OLINDA

SEASHORE NEAR TAMANDARÉ, PERNAMBUCO

A NATURALIST IN BRAZIL

The Record of a Year's Observation of her Flora her Fauna, and her People

BY

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TRANSLATED BY

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With Illustrations

BOSTON AND NEW YORK
HOUGHTON MIFFLIN COMPANY
1931

The German original, "Das Antlitz Brasiliens," first published by R. Voigtländers Verlag, Leipzig, in 1927

FIRST PUBLISHED IN ENGLISH IN 1931

PRINTED IN THE U.S.A.

TO MY KINDLY HOSTS

THE VERY REVEREND FATHERS SUPERIOR OF THE
BENEDICTINE MONASTERIES

D. PETRUS ROESER
ABBOT IN OLINDA

D. PETRUS EGGERATH
ARCH-ABBOT IN RIO

D. MICHAEL KRUSE
ABBOT IN SÃO PAULO

IN HEARTFELT GRATITUDE
AND FRIENDSHIP

During the year of my sojourn in Brazil, and my subsequent visit of some months to the Argentine, and on the voyage out, I met with so much kindness and hospitality that I can name only a few of my good friends, though they may rest assured that none of them are forgotten.

My first relations with Brazil were due to Fräulein Elsa Schwab, of Parahyba, and Professor de Barros, whose friendly hospitality I subsequently enjoyed at his home in Parahyba. To the Secretary of State of Pernambuco, Dr. Samuel Hardman, who invited me to Brazil, and in whom I always found sympathy for and understanding of my work, I express my thanks elsewhere.

For the greater part of the time I enjoyed the hospitality of the Benedictine monasteries, to whose Abbots this book is therefore dedicated; but I have grateful memories also of the Franciscans in Olinda, Bahia, Rio, Petropolis and São Paulo, and of the Benedictine nuns in Misericordia and Caruarú. For weeks I lived in the home of my good friend Dr. P. A. Nusse and his kindly Portuguese wife; in São Paulo—during the difficult days of the Revolution—I enjoyed the hospitality of Herr Alfred and Frau Alice Weissflog and my dear "Lion"; and in Buenos Aires the time spent with my friend and colleague in the protection of natural beauties, Professor Hugo Salomon, and his wife and daughter, made a happy conclusion to a delightful visit. I must also express my gratitude to my kind friend, Dr. Virginia Rodrigues, and her children, in Olinda, and to Senhor and Senhora A. O. Coimbra, Herr and Frau Bökmann, and Herr and Frau A. Krönke, who literally made me feel at home. In Rio, Herr Kurl and Frau Elizabeth Runge and her daughter Gisela were most kind to me, and in São Paulo Herr Richers. I must thank the German Minister, Dr. Plehn, and the German Consuls in Recife, Rio, São Paulo, and Santos, for their kindly assistance, and the German clubs for their friendly hospitality. Among the scientists and scholars of Brazil, I must thank Dr. Lutz, Dr. Costa Lima and Father Borgmeier (O.F.M.) in Rio, Herrn Lüderwald, Hoehne and Decher in São Paulo, and Professor Lehmann Nitsche in La Plata for many interesting hours. And I do not forget the hours spent with Herr Arp, Dr. Regendanz, Dr. Christoffel, and above all, my friend Dr. E. Bethke.

PREFACE

THE German title of this book is *Das Antlitz Brasiliens*—"The Face of Brazil." The "face" of the country is its landscape, its flora, its fauna: all that we include by the word "Nature." These things constitute its most eloquent and impressive speech, and to those who can hear it—and to them alone—the country reveals its greatest beauty, and the intimate secrets of its being.

He who wishes to derive both enjoyment and profit from a voyage to Brazil must above all become intimate with the natural life of the country. After all, what is it that he most of all wants to know? He wants, I think, to know the name of those great scarlet flowers; and what sort of palms those are that overlook the housetops; and how one can best enjoy a sight of monkeys, parrots and humming-birds. But as yet he has no conception of the wonders which are revealed by an insight into the lives of the orchids and the insects! The best Brazilian "Baedeker" will therefore be a guide to the flora and fauna of Brazil. And the task which the author has proposed to himself in the writing of this book is to produce such a guide.

But the glittering virgin forests, the sun-steeped wildernesses, the sea-beaches overshadowed by rustling palm-trees, invariably offered me, when I went forth each day with renewed expectation, so much that was new and lovely and fascinating, that I very soon formed the resolve to share what I had felt and seen with those for whom a voyage to Brazil is impracticable. My own visit to that country followed upon an invitation from the Government of the State of Pernambuco; my task was to combat the insects which were injuring the plantations. My work led me first into the interior of the north-eastern States, and later southwards, to São Paulo and Jahú. It not only gave me an insight into all the branches of Brazilian agriculture and colonization; it led also to friendly intercourse with the Brazilians, so that I was able to complete my description of the country and its civilization by some account of the character and the customs of its human inhabitants.

This book, therefore, is based on my own personal experiences, just as the illustrations in the text are sketches from my own pen, while the photographs are enlargements from my own negatives (I used a stereoscopic camera, the plates being 4·5 by 10·7 cm.). But it has not been my aim to give a description of my travels. I wish rather that my own experiences might enable me to transport the reader bodily into the scenes which I have described, and enable him to make such discoveries as I made myself. Even the expert, I hope, may find something new in these pages. And to this end I have kept all personalities in the background, in order that Nature may speak with her own mighty voice. In each chapter the image of a landscape is revealed in the harmonious co-operation of its flora and fauna, with all its characteristic colours and voices and perfumes. Sixteen years ago I was able, in the same way, to study the Indian island of Ceylon, so that comparisons between the two tropical countries inevitably suggested themselves; I was able to define their characteristic features; and thus my book deals not merely with the flora and fauna of Brazil, but also, in a certain degree, with tropical Nature in general; so that I hope it may be equally welcome to the ordinary reader and to the scientist. And if at times the image of my German homeland has been reflected in the mirror of the tropics, this juxtaposition of images will but more sharply define the individuality of either landscape.

Towards the end of my sojourn in the country I lectured in Portuguese before the Agricultural Society and the Faculty of Philosophy in São Paulo; and I also introduced my German fellow-countryfolk in Recife, Rio, São Paulo and Buenos Aires, by courses of lectures and instructional excursions, to the flora and fauna of Brazil. Many who attended these lectures and excursions have assured me that they have now, for the first time, learned to love the new home which has revealed to them so many lovely and fascinating things, of whose existence, in such abundance, and so close at hand, they had never had any suspicion. In so far as this book proceeds a little further on the lines thus indicated, it has yet a third purpose: to be a book on Brazil for the Brazilians. Nature is here considered not by the critical eye of an outsider, but by a heart full of love for the sunny land; and the plants and animals are given the native names which the Indians have so aptly bestowed on them. The scientific denominations will be found in the Index, which is almost a handbook in itself, and which, I hope, will make it easier for subsequent explorers and scientists to find their way about, since in addition to giving the derivation and affiliation and peculiar features of plants and animals, it contains references to the principal authorities for those who desire to study the various species more particularly.

May the readers of my book learn to see the face of Brazil as the countenance of a friend! And when they have learned to love it, may they also do what lies within their power to prevent its disfigurement, and to ensure that the splendid and individual flora and fauna of the land shall be preserved. In order to set a good example, I refrained, all the time I was in Brazil, as I refrained while I was in Ceylon, from ever firing a shot. And I can here assure the reader that the best way of understanding a whole country—as it is the best way of understanding an individual creature—is to love it.

KONRAD GUENTHER

CONTENTS

CHAPTER PAGE

PREFACE 9

LIST OF PLATES 15

LIST OF FIGURES 17

I. THE BEAUTY OF BRAZIL 21

II. THE OCEAN SHORE 38

III. THE SCAVENGERS OF THE SHORE, AND THE MANGROVE WOODS 53

IV. THE VIRGIN FOREST 63

V. THE LIANAS 88

VI. EPIPHYTES AND PARASITES 100

VII. IN THE DESERT 113

VIII. TROPICAL GARDENS 131

IX. PLANTATIONS 145

X. THE ANIMAL WORLD OF BRAZIL 158

XI. NATURE AS AN ORGANISM 183

XII. THE MOSAIC OF COLOURS 206

XIII. THE FLOWERS OF BRAZIL 230

XIV. THE SYMPHONY OF VOICES 247

XV. CAREFUL MOTHERS 266

XVI. PIONEERS OF COMMUNAL LIFE: WASPS AND BEES 289

XVII. THE COMMUNITY OF THE ANTS 303

XVIII. THE TERMITES 325

XIX. SNAKES AND BLOODSUCKERS 337

XX. THE BRAZILIANS 356

INDEX WITH SCIENTIFIC DENOMINATIONS OF PLANTS AND ANIMALS, THEIR DERIVATION AND AFFILIATIONS, AND OTHER PARTICULARS 373

LIST OF PLATES

PLATE

I. THE FRANCISCAN MONASTERY, OLINDA — *Frontispiece*

SEASHORE NEAR TAMANDARÉ, PERNAMBUCO — ,,

TO FACE PAGE

II. CLOISTERS OF THE BENEDICTINE MONASTERY IN OLINDA — 40

JANGADA (CATAMARAN) ON OLINDA BEACH — 40

III. TWO OF THE ISLANDS OF RECIFE—GOVERNMENT PALACE — 56

HOUSE IN CAXANGA, NEAR RECIFE — 56

IV. BAHIA, FROM THE IMMIGRANT STEAMER *GELRIA* — 64

VIEW FROM VICTORIA, ESPIRITO SANTO — 64

V. THE ENTRANCE TO RIO BAY, FROM THE SUGARLOAF — 72

THE ATLANTIC COAST TO THE NORTH OF RIO DE JANEIRO — 72

VI. VIEW FROM THE SUGARLOAF: LOOKING SOUTHWARDS OVER RIO — 88

THE SUGARLOAF — 88

VII. THE GAVEA, FROM THE SHORE — 104

THE GAVEA, FROM THE TIJUCA FOREST — 104

VIII. OLINDA — 120

COCONUT-PALMS IN OLINDA — 120

IX. CASHEW-WOOD, PERNAMBUCO — 128

OIL-PALMS, OLINDA — 128

MACAIBA-PALMS — 128

X. MANGROVE FOREST NEAR RIO — 136

URUBÚ VULTURES — 136

SWAMP-CRAB — 136

XI. THE EDGE OF THE FOREST, ALTO DA SERRA — 144

EDGE OF BARREN LANDS, PERNAMBUCO — 144

FOREST SOUTH OF RIO — 144

XII. SERINGAL. TREE-TOPS IN THE FOREST — 160

SERINGAL. MASSARANDUBA TREE — 160

XIII. VIRGIN FOREST, ALTO DA SERRA. IN THE CENTRE, A PALMITO — 162

ON THE RIO PAQUEQUER, NEAR THEREZOPOLIS — 162

XIV. VIRGIN FOREST, CEYLON — 176

VIRGIN FOREST, KUBANY, THE BÖHMERWALD — 176

XV. VIRGIN FOREST, SERINGAL — 178

BURITY-PALM IN SWAMP-FOREST — 178

LIANAS IN VIRGIN FOREST, PERNAMBUCO — 178

XVI. TREE-FERNS IN FOREST NEAR NOVA FRIBURGO (2,600 FEET ABOVE SEA-LEVEL) — 184

TREE-FERNS IN CEYLON (AT 6,500 FEET) FOR COMPARISON — 184

PLATE — TO FACE PAGE
XVII. PETROPOLIS. IN THE FOREGROUND, GERMAN SCHOOL-CHILDREN 192
ARAUCARIAS IN FRONT OF THE YPIRANGA MUSEUM, SÃO PAULO 192
XVIII. BROMELIAS IN PERNAMBUCO 200
ARISTOLOCHIA GIGANTEA IN THE BOTANICAL GARDENS OF PERADENIYA, CEYLON 200
XIX. TREE-STRANGLING FIG, PARAHYBA, STILL GROWING ON THE SUPPORTING TREE 208
OLD TREE-STRANGLING FIG, MATURE, AT MONTE, OLINDA 208
XX. IN THE DESERT OF PARAHYBA 216
PILLAR-CACTUS AND FIG-CACTUS 216
XXI. A FERREIRO'S NEST 232
VULTURE-NETTLE-TREE 232
PILLAR-CACTUS 232
OITICICA 232
XXII. MANGO-TREE, SHOWING FRUIT, AND MACAIBA-PALMS 256
BREADFRUIT-TREE 256
JACA-TREE 256
XXIII. CASTOR-OIL PLANT AT THE EDGE OF THE FOREST 272
SUGAR-CANE, TAPÉRA, PERNAMBUCO 272
XXIV. VIEW OF THE "PARROT'S BEAK," TIJUCA MOUNTAINS 288
BUILDING A NEGRO'S HOUSE 288
TRAVELLING BY TROLLEY 288
XXV. COTTON-FIELD, SOLIDADE, PARAHYBA 296
COFFEE PLANTATIONS IN THE HILLS NEAR JAHÚ 296
EUCALYPTUS FOREST, CAYEIRAS 296
XXVI. LA PLATA MUSEUM, ARGENTINA 298
PREHISTORIC GIANT ARMADILLO IN THE LA PLATA MUSEUM 298
XXVII. THE MORE PRIMITIVE MAMMALS OF BRAZIL 322
XXVIII. BIRDS OF BRAZIL 340
XXIX. (I) MIMICRY 344
(II) INSECTS WHICH MIMIC LEAVES AND TWIGS, AND SOME OTHERS 344
XXX. TERMITES' NEST ON THE LAND OF THE AGRICULTURAL COLLEGE, TAPÉRA 346
SAGUIM MONKEY 346
DRAWING VIRUS FROM A RATTLESNAKE, BUTANTAN INSTITUTE 346
XXXI. BRAZILIAN SNAKES 352
XXXII. THE OLDEST HOUSE IN BRAZIL, PARAHYBA 368
A HOUSE IN RECIFE 368

LIST OF FIGURES

FIG. PAGE

1. TWO FRUITS OF THE CASHEW-TREE, ON LEAF 41
2. THE CARAVELLA (PHYSALIA). A JELLY-FISH (PELAGIA). A COFFER-FISH 45
3. A SECTION OF A LIANA STEM 90
4. LEAF OF THE CLIMBING PALM, JACYTÁRA. YOUNG SHOOT OF THE "CAT'S-CLAW" CREEPER 93
5. SECTION OF STEM OF A BAUHINIA 95
6. BLADDER-TRAPS ON THE ROOTS OF THE BLADDERWORT 108
7. THE "GREYBEARD," AN EPIPHYTIC BROMELIA 109
8. AGAVE IN BLOOM 116
9. SPRIG OF COTTON-PLANT 152
10. ITAWIRA, ON THE COAST OF ESPIRITO SANTO 161
11. PIRANHA 176
12. MANATEE OR PEIXE BOI 193
13. PASSION-FLOWER OR MARACUJÁ 231
14. A TROPICAL ORCHID 242
15. A FIG, IN SECTION, SHOWING THE INTERIOR OF THE URN, WITH THE GALLS OF THE GALL-WASP. A SINGLE FLOWER WITH THREAD-LIKE PISTIL 244
16. THE YUCCA-MOTH 245
17. LEAVES GLUED TOGETHER BY A CAT-FROG AND CONTAINING THE EGGS 272
18. GOELDI FROG WITH A POCKET OF EGGS ON HER BACK 273
19. THE PURSE FROG 273
20. SALAMANDER-FISH 275
21. FLAT-HEADED CATFISH WITH EGGS ON BELLY 276
22. HERCULES BEETLE 278
23. ICHNEUMON ON CATERPILLAR 282
24. NEST OF THE PASTEBOARD-WASP. A NEST OF POLYBIA SCUTELLARIS 294
25. STINGLESS BRAZILIAN BEES 297
26. LEAF-CUTTING ANTS OR SAUVAS 303
27. THE SAUVAS' GUEST, SHOWING THE HAIRS WHICH EXUDE AN INTOXICATING SAP 307
28. SAUVA QUEEN IN HER CLOSED BURROW 310
29. SOLDIER OF THE DRIVER ANT 312
30. MIMECITON, A BEETLE WHICH MIMICS AN ANT 318
31. ANT-GARDEN ON THE BRANCH OF A TREE 318
32. SECTION OF AN IMBAUBA-TREE, INHABITED BY ANTS 319
33. TUBULAR NEST OF THE BEARD AZTEC 320
34. TERMITE SOLDIER 326

FIG. PAGE
35. SOLDIER AND WORKER OF EUTERMES RIPPERTII 327
36. SCHEMATIC REPRESENTATION OF A NEST OF EUTERMES RIPPERTII 328
37. TERMITE QUEEN SURROUNDED BY WORKERS AND GUARDED BY A RING OF SOLDIERS 329
38. A FLY, THE GUEST OF THE TERMITES 335
39. FEMALE SAND-FLEA OR JIGGER 351
40. HEAD OF HOOKWORM FROM HUMAN INTESTINE. THE LARVAL STATE 353

PRONUNCIATION OF BRAZILIAN NAMES

c before *a*, *o*, *u* = *k*; before *e*, *i*, *y* = *ss*.

ç = *ss*.

ch = *sh*.

g before *a*, *o*, *u* is hard; before *e*, *i*, *y*, soft like the French *j*.

j = the French *j*.

h is mute. In *lh* and *nh* = *j*.

s at the beginning of a word is sharp.

qu = usually *k*.

x usually = *sh*, but sometimes a soft *s* (Caxirra = Casirra).

z = soft *s*.

~ written above a vowel indicates a nasal *n*. São = Ssaon*g*, *a* and *o* constituting a diphthong.

ei = closed *a*, or French *ê*. A final *e* usually becomes an impure *i*, and a final *o* = usually *u*. *M* and *n* are often nasal: Sem fim = sseng fhing.

The accent ' indicates that the vowel is open, and usually emphasized.

In Brazil a more clear-cut and less eroded Portuguese is spoken than in Portugal. The language of the Discoverers, which was nearer Spanish than is the language of to-day, has survived in Brazil; it is a language of great beauty, and very musical.

A NATURALIST IN BRAZIL

I

THE BEAUTY OF BRAZIL

The sea that laves the palm-fringed shores of Pernambuco gleams like an emerald. Never before had I seen a sea of such a vivid green; and when, on entering the harbour of Recife, the capital of the State of Pernambuco, and looking out over the far-flung stone breakwater, where from time to time the foam of the breakers spouted up in snowy clouds, I beheld this green radiance, I could hardly at first believe that this was the ocean over which I had been voyaging.

To the north of Recife, greeting the approaching traveller from afar, rises the hill of Olinda, green with gardens, rustling with palm-trees, traversed by winding streets of white or brightly-coloured houses, adorned with many churches, and crowned by a twin-towered cathedral. Here, on a smaller hill, is the venerable square white building of the Benedictine monastery of Olinda, surmounted by the two towers of its chapel. For many months I was the guest of the kindly fathers and their abbot, and so my sojourn in Olinda, which brought me every day a fresh wealth of impressions and experiences, showered upon me as from a tropical horn of plenty, was further enriched by the peace of the quiet conventual life.

I fell asleep with the surging of the sea in my ears, and my first impression, on waking, was of the green light thrown upon my bed by a mirror which hung beside the window, wide open day and night. And even when the year of my sojourn in Brazil was nearly ended, the sight of the ocean at Pernambuco impressed me, day by day, as something new and wonderful. For as the light that falls upon it changes, so the sea at Pernambuco changes colour like a diamond. Slowly a band of violet extends along the horizon, and streaks of the same violet traverse the green surface, fading even as they float across it, and suddenly there is here a flash of red, and yonder a blaze of blue, and now all the colours of the rainbow are spilt upon the sea, until it seems to be not water, but a vaporous fabric of radiant ether.

It was difficult to turn from the incomparable picture framed in my window, and to set about the work of the day. In the upper cloisters I stood or sat by my breeding-cages; the sun shone through the lofty arches, and the fan-shaped crests of the palm-trees rose above the silent courtyard. The little Brazilian hedge-sparrow, the Carrixa, flew in, perched himself on one of the poles of the awning, and broke into his cheerful, trilling song. Then came breakfast in the refectory; then "recreation", a pleasant time of wandering about the cloister, a time of conversation, grave or gay, followed by the work of the afternoon. But the best part of the day was when the sun began to sink. Then I went into the garden, sat on my camp-stool before the deep red funnels of the morning-glory, and watched the humming-birds, which suddenly hung in the air before the flowers as though suspended by invisible threads, while a faint hum was emitted by their beating wings, and rays of light flashed from their bronze-green plumage. With my field-glasses I followed the movements of other birds, for new species were constantly making their appearance; I watched the insects awhile, and then, wandering down the steep garden under the coconut-palms and genipa-trees, I opened the door in the convent wall, and went down to the sea, the palm-trees of the gardens on either hand rustling above my head (Plate 8).

It was a joy to lie down on the sand and surrender my lightly-clad body to the caresses of the trade-wind, to the clean, invigorating, brine-scented breath of the boundless ocean. The tall shafts of the coconut-palms beside me stood out in bold relief in the horizontal light, while the green and yellow shadows of the great feathery leaves flashed with glittering reflections.

Before me the sandy escarpment of the beach fell steeply, and beyond it lay spread the ocean in the light of the setting sun. The long, advancing rollers reared themselves, and broke, and fell, spouting up, with a dull thunder, against the projecting walls. The foaming crests flashed in the rosy light, lifting themselves bodily from the blue-shadowed troughs of the swell, and in that tender radiance there was something unearthly in their beauty. Far to the south stood forth the islands of Recife, the stone houses glowing with rosy light; a steamer was leaving the harbour, flying a long pennon of following smoke.

The fishing-boats, now approaching, now receding, gave an elegiac note to the brilliant scene. When they approached the shore, and the sails fell, it looked as though their occupants were sitting on a bench in the water. For the fishing-boats of North-eastern Brazil are rafts or *jangadas*, of a primitive type adopted from the Indians. Seven to nine logs of a particularly light wood, the *pau de jangada*, are bound together to form the hull; there is a mast and sail, a bench to sit on, a basket for the catch, and a rudder, and that is all. I was often astonished to see how safely the *jangada* rides a rough sea, but the light wood cannot sink; the waves, of course, break foaming over boat and crew, but the men are used to this, and their scanty clothing soon dries in the sun (Plate 2).

The light of the ocean on the north-east coast of Brazil exerts a magical spell. Men who have once felt this magic are always drawn back to these latitudes, and the inhabitants of these north-eastern States of Brazil are well known to be peculiarly faithful to their home. This I can well understand. It is as though the clear radiance of the air and the water were imbibed by the soul of man, filling it with cheerful serenity. I at least found that in this country such dismal moods as might arise (perhaps as a result of news from home, for this was the time of the inflation) could not long endure. Assuredly the flood of light that pours down upon Pernambuco is in some degree responsible for the cheerful temper of its inhabitants, which constantly impresses the foreigner.

It is not only the sea that shines and glitters; even the leaves of the trees reflect flashes of light from their smooth upper surfaces, and not a month goes by but some species of tree puts on a shining garment of blossoms. These latitudes know nothing of the black-and-white winter of Europe. There is, of course, an alternation of seasons in Brazil, and these, owing to its position in the southern hemisphere, are the contrary of our own; the north side of the houses, too, is the sunny side, as one realizes in São Paulo, and even more clearly in the Argentine. In North-eastern Brazil, however, there is no great difference between the months; and every day, with but little deviation, the sun rises at six and sets at six.

Likewise, in the course of the year there are no great variations of temperature. When I arrived in Pernambuco, at the beginning of July, it was still winter; and then the mean temperature was 77° by day, with a minimum of 62·6° at night. There were often heavy downpours of rain, which lasted perhaps an hour, but which always gave way to blue sky and bright sunshine. From August onwards there was rarely rain; the weather was always magnificent, and it was the same in September; while from October to the early part of December it rained once more, but only now and again;

and these rains are known in North-eastern Brazil as the *cajú* rains, for the fruit of the cashew-tree needs them in order to ripen and fill with sap.

In December the rains cease, and the dry season begins. The moist and heavy fragrance of the tropics is replaced by a sharp, insistent odour of fallen leaves, and the green of the grasses, which at other times invades even the roads, now turns grey, and everywhere the bare red soil emerges. Many trees stand leafless, while others, like the splendid Flame Acacia, choose this month to deck their spreading crowns with a royal mantle of scarlet flowers as large as tulips. The temperature rises to 84° in the shade; at night it is hardly cooler. In the morning one lifts one's head from a wet pillow, and during even a slight exertion, such as playing the piano, one has constantly to wipe the perspiration from one's forehead. At the end of March there are once more frequent showers, and the morning temperature is only 77°; once again all things deck themselves in luxuriant green, and of a morning one walks refreshed in the moist fragrance of the gardens.

In Rio de Janeiro the heat from November to February is often worse than in North-eastern Brazil; the city, shut in by the hills, is airless, the streets glow with heat, and the nights are sleepless; until at last, after some days of torment, a thunderstorm beats up behind the peak of Tijuca, and coolness falls with the rustling rain. In May and June, indeed, it is even lovelier in Rio; the nights are cool, the days magnificent, and one enjoys them all the more securely in that fine weather prevails about this time. In São Paulo, indeed, which lies at an altitude of 2,400 feet, the nights are really cold at this season, and of a morning there is fog in the streets; one shivers, and wraps oneself in one's cloak, until about ten o'clock the sun breaks through, shining in a radiant blue sky, and the temperature becomes comfortable. The whole of South America is richer in sunlight than Europe.

The reason why the Brazilian summer is more easily endured in Pernambuco than in Rio is the fact that in the former State the trade-wind constantly blows upon the coast. In August, the windy month, it blows hard from the south-east; in the summer it veers to the north-east, but it is always to be felt as a refreshing breeze, noticeably cooler than the still air, and on its way across the endless plains of the ocean it brings with it a purity which is plainly perceptible. This wind is a precious boon. A similar wind blows off the coast of Ceylon—the south-west monsoon—but only during the months of the northern summer; then follows the sultry season of variable winds, and from October onwards the north-west monsoon blows, which has passed over the mainland of Asia, and has not, therefore, the coolness of the ocean wind. In Ceylon, accordingly, I have felt the heat even more severely than in Pernambuco, although the island lies just eight degrees north of the Equator, whereas Pernambuco lies just as far south of it. In Pernambuco, as early as one o'clock in the afternoon, when the wind began to blow more briskly, I was able to go for a walk, while in India at that hour walking would have been most exhausting. While I was in Ceylon I never dared to go out without a sun-helmet, for otherwise headache and illness would have resulted, whereas in Pernambuco I always wore a straw hat without coming to any harm. Apparently the sunlight of Brazil has a different quality to that of India. In Ceylon the yellow rays appear to be predominant, so that when taking photographs, even in the most brilliant sunlight, one has to give a longer exposure than in Brazil, or even Europe.

The Brazilian climate, of course, cannot be compared with the European—at least as regards its effect on the human body. If here in Freiburg I climb the Bromberg of an afternoon—a height of a thousand feet—hardly two hours have elapsed before I am home again, refreshed, and I go at once to my desk and resume my work; whereas to climb the hill of Olinda, little more than three hundred feet in height, required a very much greater effort, and after a walk I was exhausted rather than refreshed. After an excursion of any length I threw myself down on the sofa or the bed, with arms and legs extended, and it was some minutes before exhaustion gave way to repose. Hence the Brazilians dislike active movement, and walking as a form of exercise is quite unknown to them; for example, on renting a house it becomes a matter of some importance that the electric tramway should not merely pass the house, but also that there should be a halting-place as nearly opposite the house as possible. When I had to pack my trunk in Pernambuco I always stripped to the skin, and even then I had often to sit down, and mop my forehead, and dip my hands in water, and was always thankful when the task was ended.

Similarly, far more notice is taken of inclement weather than is usual with us. Brazilians avoid the rain as they would the plague, and in rainy weather the concert-halls and lecture-rooms are empty. It is true, of course, that a chill may readily have serious consequences. The newcomer in particular should take good care that his health remains unimpaired, for then he will be best equipped to meet the dangers of infection. Most important of all is a regular action of the bowels; an intermission even of a day is said to be dangerous, as the toxins of putrefaction accumulate in the bowel. Fortunately there are in Brazil fruits which have every possible kind of effect, from those which impede the digestion to those which promote it, some gently and others more vigorously, as we shall see in Chapter VIII. To be moderate in all things is the first rule for the maintenance of health in the tropics.

I myself enjoyed the best of health all the year round, in Brazil as in Ceylon. It is true that I was living under favourable conditions, and was able to work at that time of day which suited me best, and in accordance with my inclination. Those who go to Brazil as employees in business houses have to work at prescribed hours, which is much more exhausting; and any immigrant who attempts to do the work of an agricultural labourer in tropical Brazil is forced to realize that such work is difficult for the strongest man, and impossible for any other, and that he can never work so hard, and live so frugally and cheaply, as the native-born agricultural labourer.

Despite all such drawbacks, however, the tropics exert a magical fascination. When I think of Brazil it is not Rio de Janeiro that rises before me, with its proud coronal of mountains and its incomparable bay: the north-eastern coast of Brazil has engraven itself more deeply on my heart.

And this chiefly because this part of Brazil is more strongly individual than the south, which is already only too far modified by European influences. The north-east is genuinely Brazilian. Cities like Olinda, Parahyba, and even Bahia, have a character of their own. Here the old colonial style, best adapted to the country, and most harmonious in effect, is still frequent, giving the streets a charm of their own. In the matter of architecture, therefore, I find Olinda and Bahia more pleasing than Rio or São Paulo. Similarly, in the north-east of Brazil the old Portuguese manners and customs still survive with all their charm, and those who penetrate further into the country will find reminiscences of them even in the manners of the Indian aborigines. Again, the repose dictated by the climate impresses the traveller agreeably. Of this I shall say more in my final chapter.

And for these reasons a journey through Recife, despite its 234,000 inhabitants, is not so trying as a journey through Rio or São Paulo. Without being pressed or hurried, one steps on to the "Bond"—

the electric tram—whose open transverse benches are swept by the sea-breeze. Looking comfortably about him, the passenger glides through the business quarter with its sea-girt islands (Plate 3), with their lofty buildings, or the residential district. Here the houses are almost exclusively of one storey only, so hidden in their gardens that even from the hill one sees nothing but green, and asks oneself in astonishment wherever the city can be, since the only houses visible are the tall commercial buildings on the "Recife" or reef. But a ride through the garden city was always a pleasure to me, for every time one or another species of tree had decked itself in a splendour of blossom such as I had never seen. And there was always the sunlight, and the blue sky, and the people in the streets, who enhanced the charm of the picture not only by their white or brightly-coloured clothes, but also by the alternation of white, brown and black faces; for the negroes and mulattoes give the street scenes of Pernambuco—and still more those of Bahia—a character of their own.

But the best thing about the tropics, in my opinion, is that one is always, by day and by night, in touch with Nature. Just as the lightly-clad body is in immediate contact with the air, so that one feels always free and comfortable, so in the tropics there are no closed rooms. A lady in India once told me that she could no longer live in Europe, the rooms were so oppressive; she often had the feeling that she could not breathe.

Most of the houses in Pernambuco, Parahyba, and other States of tropical Brazil have no glazed windows, but only shutters with diagonal slats, a protection against the sun by day and intruders by night. One enters the house as in Europe one enters a garden-room or arbour, in which one does not even feel that one has left the garden (Plates 3 and 32). All the windows and doors are open; even in the railway-carriages no one is afraid of draughts, and the windows are open on both sides.

Even in the cloisters I was surrounded by the fresh air and by living creatures. There were all sorts of animals which were only waiting to be caught, and which I kept for a while in order to observe them. In my room were a boa-constrictor, a coral-snake, lizards and frogs—all in suitable cages; a lively land-crab clattered with his claws under my bed, and once I had for a guest a peccary, who behaved like a little dog. Outside, in the cloisters, were whole rows of boxes and cages, containing armadillos, marsupials, bird-spiders and insects of every kind. All these creatures I kept a few weeks and then released. Many of them, including the boa-constrictor, became so tame that I parted from them with regret.

To these creatures were added certain voluntary guests. Each morning I was awakened by the little hedge-sparrow, who flew into my bedroom singing, in order to hunt for insects. In the evening, when I was writing up my notes, my task was by no means easy, for every moment some insect flew in; often the whole table was covered; and now and again a great cockchafer crashed into a corner of the room, and then, angrily buzzing, and lying on his back, performed a wild dance across the floor. And over and over again I had to jump up and see whether my new guest was not perhaps of a specially interesting species.

At night a gentle crackling was audible in my bedroom. It was some time before I could make out what it was. The cockroaches, which in Brazil are gigantic insects, as big as one's thumb, tried to fly into my room at night, in order to feast on the breadcrumbs on the floor, or gnaw the bindings of my books for the sake of the glue; but most of them were caught outside my window by the bats that were flying to and fro. These bats then came into my bedroom, hung by their hind legs from the ceiling-lamp, and there crunched their prey, so that in the morning the wing-covers of their victims lay about the floor. Other nocturnal hunters in my room were certain delicate lizards of a yellowish colour, which were so transparent that one could see the blood pulsating in their arteries. With their outspread spatulate fingers they clung firmly to the wall, and they were even able to run upside down across the ceiling. If I struck a light at night I often found one of these geckos adhering to the wall, where its dark eyes, whose pupils, like those of a cat, were vertical slits, sparkled in the light of the lamp. If I made the slightest movement the little creature disappeared in a flash behind its accustomed refuge—a picture-frame. In many parts of the country, I am sorry to say, the Brazilians call the gecko the *vibora*, or viper, although it is a lizard and not a snake, and kill it, for they declare that it is poisonous. As a matter of fact this *vibora* is a very useful creature, since it catches mosquitoes, bugs, and other blood-sucking insects. In Ceylon, where this pretty lizard is valued as it should be, the gecko often becomes so tame that it climbs on to the table punctually at supper-time and permits itself to be fed.

I shall never forget the hours that I spent in the house of some very dear friends in a suburb of Recife. As we sat at the supper-table, pleasantly chatting, the doors and windows were wide open, and with the scent of the vegetation the shrilling of the cicadas and the piping of the frogs entered the room. It was as though the life and activity of Nature had invaded the very room by way of the verandah, where the moonbeams, drifting through the foliage, covered the floor with starry spots of light. For even in the room the electric light showed little frogs moving silently across the walls, while from time to time a rhinoceros-beetle or some other insect fell buzzing on the white table-cloth, or the fire-flies, with their green lanterns, performed a faëry dance.

It was this continual presence of Nature all about me that I missed most sorely when I returned to Europe.

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The voyage from Pernambuco to the South is magnificent, especially if one travels not by one of the great ocean-liners, but by one of the Brazilian line of coasting-steamers, the "Costeira," whose names begin with "Ita" (the Indian word for rock). The Ita steamers sail so near the coast that the latter is almost always in sight. They are not, however, to be recommended to travellers who suffer from sea-sickness, since they are built with almost flat bottoms, and keelless, in order that they may be able to enter the shallow lagoons of the southern States. They therefore roll considerably, even in a gentle swell, and the South Atlantic, being swept by the trade-wind, is never quite calm. Nevertheless, I much enjoyed the voyage on the *Itaquatia.* She was a clean, handsome vessel, the food was good, the Brazilian passengers were cheerful and friendly, and it was delightful to lie in a deck-chair on the flat roof of the saloon, and gaze across the sea to the constantly changing coast. Here was a natural cinema, of the loveliest kind imaginable. One's enjoyment was still further enhanced by a glass of good Rio Grande wine.

We put into Maceió, the capital of the State of Alagoas. The roadstead is a brilliant green, as in Pernambuco; sailing-boats, gently heeling, shoot across the water. Further to the south the bluffs and escarpments of the coast appear to be gleaming with freshly-fallen snow, for the green of the hanging woods which run down to the yellow line of the beach is broken by patches of dazzling white. These are deposits dating from an early period of the earth's history, the Eocene. For a long while the steamer glides past the white and green hills of the coast, but at last houses are seen on the level of the beach, and above them towers and domes peep over the ridges of the hills. Now a lighthouse appears, surrounded by circular walls that have the look of a fortress, and behind it is a bay. We have reached Bahia (Plate 4). The steamer has at first to describe a great curve, so that it seems as though she meant to pass the bay, but then, suddenly, she turns sharply to starboard, and on our right the city unfolds itself, consisting of Upper and Lower Bahia. Funicular railways lead from the lower to the upper city, and the houses are overtopped by churches. Like a blue lake the bay stretches far to the south, divided from the open sea by a hilly island.

The steamer comes to a standstill. The sky is veiled by a grey mist. Motor-boats put out from the shore, bringing the police and officials of the steamship company, and a whole fleet of canoes comes sailing up to us. Their sails are hauled down, and we see that they are full of rosy mangoes, green avocat pears, oranges, and other fruits. Brown-skinned men hold up monkeys and parrots, and also, I regret to say, boxes of the skins of humming-birds.

Over the sea, in the meanwhile, the sky begins to clear; the mist dissolves into white diaphanous clouds; the slanting rays of the sun pour down upon sea and coast. The city yonder takes plastic shape as we look; above the house-fronts rises a forest of towers and steeples; to the right gleams the dome of the Benedictine abbey, with the two towers of its west front, like uplifted forefingers. Beneath it the houses descend to the lower city like a stairway of coloured cliffs interrupted by funicular railways and slanting streets. As one drives up to the city it gradually loses itself in the green hillside, above which the royal palms lift their bushy heads against the sky. In the middle of the picture an ancient fort rears itself bodily above the white and green of the city, casting an orange reflection on the blue water.

The blue of the bay glows even more resplendent. As the wind breathes upon its surface it changes to a vivid ultramarine, while smooth streaks of a lighter blue traverse the darker colour, now close inshore, now farther out to sea. The surface of the water is like silk and satin. Above the city the horizon is flooded with green, while rounded cumuli, touched with rosy light, tower up into the heavens.

Now the sun sinks, and all at once light flashes from a thousand windows; the green of the hillside changes to a sinister, poisonous yellow. The boats surrounding the steamer speed away from it, ploughing long black furrows in the water. Like the voice of a monster, the siren gives the signal that the vessel is about to sail.

Orange and violet clouds float in the upper sky; the blue of the ether is all the more splendid by contrast. The city glows in an unearthly radiance; of a sudden it seems as though uplifted on to the hills, as though floating in an ethereal vapour.

But now the light fades, and Bahia looks empty and forsaken; a dead city, while behind it a mountain of reddish clouds towers menacingly upwards. Rosy streaks play across the water, which begins to shimmer and flicker. Overhead the clouds are dissolving, growing lighter and ruddier in hue. Now there is blue sky everywhere, besprinkled with a thousand rosy cloudlets. The sea turns from rose to violet, and then to grey. Chain-cables rattle, the ship begins to move, and steams slowly out to sea, while in the city the lamps flash out, and a sparkling cross is kindled above one of the churches.

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The State of Bahia is bordered on the south by the much smaller State of Espirito Santo. Voyaging along the coast, one enters the waters of the new State as through an inlet; for abreast of the frontier of Bahia and Espirito Santo the Abrolho Islands lift themselves from the sea. "Open your eyes!" is the warning name which the Portuguese have given these islands, which rise precipitously from the sea.

In fine weather one first sees the islands floating above the water in a rosy vapour; but as one draws nearer the yellow hills seem to be sailing on an ultramarine sea; the islands begin to spread out and rearrange themselves, and to assume more definite shapes. The dark tufted crests of coconut-palms appear; the ridges grow green, while the ruddy slopes are shaded by rifts and gulleys. The lonely watcher on the white lighthouse is said to receive food and water only once in every two months.

The Abrolhos are left astern in the light of the afternoon sun, and the next morning reveals a very different scene (Plate 10). A black jagged mountain-range looms above the sea, traversed by streaks of cloud. Sharply-pointed peaks alternate with rounded summits and crumbling declivities; there are blocks and turrets of rock that look like churches; and behind them all rises a lofty range on whose flanks the clouds lie like snow. The nearer the vessel approaches, the more plainly the green of the mountains appears, while the dividing-line of the golden sands emerges from the water. And now the mountain range is cut in two: an inlet appears, of bright grey sparkling water. The steamer enters. To the left rises a lofty cone; behind it looms a second, which is crowned by an old monastery, with steep fortress-like walls.

We penetrate further and further into the inlet, which runs inland between the mountains, like a Norwegian fjord. Hills pass us by whose rounded summits are overgrown by great rosettes of bromelias; and a wood pours out of a saddle between two heights. On a naked rock black vultures are sitting. At the end of the fjord lies Victoria, the capital of the State. Amidst the yellow houses rises the newly-built nave of a Gothic church; in the background are steep mountains; and to one side of the town, on the hillside, a white monastery lies amidst the trees (Plate 4).

Beautiful are the forms of the mountains enclosing the Bay of Espirito Santo, and the blue water glitters resplendent; yet the lover of Nature cannot gaze without regret on this wonderful scene, for, enchanting though it may be, it is like a cathedral whose windows have been shattered and its richly sculptured beauty destroyed. The noble outlines of the bay are the same as ever, but where is the primeval tropical forest which was once reflected in its waters, and the symphony of colour that delighted the eye when the rounded summits of trees, ablaze with blue and yellow flowers, and the red and orange clusters of the blossoms of the hanging creepers, were reflected in the blue flood? Lifeless now are the waters that were once alive with flocks of swimming birds, while stately cranes and herons stood upon the beach, and the hawks and vultures circled overhead.

To-day the landscape is robbed of its living jewels, and the nobler the relics of its former wealth, the more it laments the destroying hand of man.

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Even in Rio de Janeiro I often had such thoughts, and I envied De Solis, Magellan, and the Sousas, the discoverers of this incomparable bay, who saw it unpolluted as it left its Creator's hand. For the beauty of Guanabara Bay is so supreme in its natural forms and colours that no human hands could enhance it, or do otherwise than deface it. I do not, of course, deny the beauty of the *praias*, the wide avenues which enclose the bay, or the magnificence of the Avenida Rio Branco, which crosses the centre of the city—built on a projecting peninsula, from waterside to waterside, so that, looking down the length of the splendid highway, one sees at either end the lofty sides and funnels of the ocean steamers lying alongside the quays. There are many fine buildings too, and parks, and charming streets with green gardens and alleys of palm-trees in Rio, and the well-dressed shop-windows and the lively traffic in the streets exert a lasting fascination. But it is the magic of its night-long illumination that makes Rio supreme over all the cities of the world; and the Brazilian capital has justly been called the City of Light, "Cidade da Luz."

It seems as though Rio endeavoured to prepare the approaching traveller for what lies before him by a gradual enhancement of the beauty of the landscape. Coming from the south, one finds a prelude to Rio in Santos. The city, whose comfortable houses are still of genuinely Brazilian architecture, is beautifully situated on a broad peninsula; on the right and the left, across the arms of the river, rise hills with graceful contours, while in the background is the splendid range of mountains, 2,600 feet in height, which terminates the plateau of São Paulo on the seaward edge. To the south of Santos the *Praia Grande* runs for thirty-six miles along the shore; a motor track of firm grit, the especial pride of the citizens of Santos. And to the north, beyond the channel which gives access to the city, the cliffs approach the sea, enclosing the calm Turtle Bay, and forming the background of the bathing-resort of Guarujà, whose beach merges into the green foot-hills.

Approaching Rio from the north, one comes first of all to Cabo Frio, a cape which deserves its name, for here at most seasons a cool wind is blowing, and the sea is often rough. The finest view I had of this cape was at night. The steamer had made such a quick passage that she slowed down to half-speed, in order to avoid lying all night off Rio, since the harbour officials would not come aboard and give us permission to take up moorings until the morning. Quietly as a sailing-ship the *Gelria* glided through the calm sea. The coast lay at peace before us, flooded with moonlight; the hills sloped downwards in several stages to the headland, where a lighthouse poured forth its beams of light.

The ship fared onward through the night. Loftier and loftier grew the mountains. Beetling cliffs fell darkly to the sea, cloud-begirt, and seemingly void of any life. It was a wild and majestic scene, and as one stood shivering in the cool wind one felt as though one had left the tropics, as though this must be the rocky coast of Norway or of Iceland.

After passing a high pointed mountain, the "false Sugarloaf," one begins once more to see traces of humanity. A white church with twin towers lies in a lonely, moon-flooded valley of rocks. And now a dark conical mountain draws menacingly nearer, looming high into the starless sky, like a mount of Destiny. This is the Pão d'Assucar, the famous Sugarloaf, the mighty warder of the entrance to the Guanabara Bay of Rio (Plate 5).

But what is this glimmer of light on the left of the Sugarloaf, a glimmer that grows ever wider as we advance? Glittering strings of pearls lie on the water yonder, and form a dazzling wreath round the foot of the mountain. These are the lamps of the Avenida Atlantica, which every night flood the promenade of the suburb of Copacabana with a blaze of light. And now, to the right of the Sugarloaf, behind the ever-widening mouth of the entrance, one sees the city climbing the hills, glittering with innumerable lights.

The steamer drops anchor and waits for the day. In amazement one leans on the rail, gazing at all this nocturnal splendour. The breeze is warmer now; a faint odour of brine rises from the sea, and the moon sheds a long, shimmering path over the dark flood.

Reluctantly one goes to bed, and after a few short hours one is again on deck. The long rows of lights are still yonder, but in the east the heavens are growing brighter. The anchor is weighed with a rattle, a wave of foam spurts up from the propeller as it begins to revolve, and slowly the vessel forges ahead. On the left is the mighty cone of the Sugarloaf, on the right the walls of a fortress stand out on a narrow rock. Wider and wider opens the bay, and the rows of lights that skirt the shore are reflected in the water. And as though these gleaming strings of jewels were not enough, blue and red signal lamps gleam upon the water itself.

It grows lighter over the eastern range of hills, at the foot of which, facing Rio, lies the city of Nictheroy. Black and sharp the peaks and summits and ridges rise against the sky; but behind them the horizon is flushing red, and with its clear contours the landscape has a look of ineffable youth, as though it were fresh from the Creator's hand. The lights of the city are extinguished; the sun, a red ball of fire, rises above the hills. The bay is flushed with a glorious blue. In the far background, like a *fata Morgana* with turrets and jagged peaks, the Organ Mountains rise in the north.

The palaces of the great Exhibition with their domes and pinnacles lift from a blue-grey mist, and flush a rosy pink, until the whole shore lies like a rose-coloured ribbon along the edge of the light-blue water. Above it, in vivid contrast, looms the bluish wall of the mountain-range, bordered with a line of green, and from this range, towards the left, the Corcovado boldly uplifts its beak, while on the right the loftier peak of Tijuca rises into the heavens. As yet no details are visible, but the blank surface, with its vigorous outline, is all the more impressive.

The situation of Rio de Janeiro has earned for it the reputation of the most beautiful city in the world; and the Guanabara Bay is indeed incomparable. But this—which in itself would be enough to make a city famous—is combined with other charms. In Rio we have the Gulf of Naples, the coast of Amalfi, the Lake of Lucerne, the pinnacles of the Dolomites, a bit of Hamburg harbour, and the boulevards of Paris; and above all these are the hills overrun with the glittering tropical forest; while in the gardens below the vegetation of the tropics, resplendent with glowing colour, reaches its full perfection.

It is owing to this multiplicity, this truly amazing wealth and variety of form and colour, that the view of Rio is incomparably finer than that of all other cities. In the bay itself, and lying before the entrance, no less than ninety-eight islands add to the variety of the scene, and the surrounding hills sound every note of the gamut from the suavest to the wildest and most grotesque formations. And yet this riven chain of mountains is the result not of volcanic forces, but, as we shall read in the tenth chapter, of alluvial deposits, and subsidences, and erosion.

If the philosopher Hegel had stood before the mountains of Rio he could not have turned away from them with the words: "They have nothing to say to me except that they exist," as he is said to have turned away from the Swiss Alps. I have seen few landscapes which so insistently preach the gospel of *becoming* as the mountains of Guanabara Bay. Just as some pictures are so vividly painted as to give the spectator the illusion of motion, so the mountains that girdle Rio seem drawn with such an impetuous rhythm that the eye finds movement everywhere. It is as though some cataclysmal cyclone had raged over the country. Viewed from the land, indeed, or from outside the bay, the Sugarloaf towers into the sky as a cone of symmetrical proportions, but seen from Nictheroy it leans over landwards, and the neighbouring hills as well seem to cower like trees before a gale.

I often ascended the Sugarloaf by way of the cable railway. A small car, like a lift, sways upwards over the intervening chasm (Plates 5 and 6). On each occasion I spent five hours on the summit, for I was so fascinated by the view that I could not tear myself away. Outside the harbour lies the ocean, a tender blue, as though drawn in pastel. The horizon is defined by a milk-white line. The islands float in a milky-bluish vapour; they seem not to touch the water, and only their rounded tops rise clear-cut against the sky. Far below lies the harbour mouth; the waves that enter from the sea are visible only as the faintest crinkling of the surface. An ocean steamer is putting out to sea; from this height it looks like a toy. Slowly its bows rise and fall in a white glitter of spray.

Yonder the peninsula of Nictheroy stretches out into the bay. The hills of the opposite shore fall steeply to the water, but those behind uplift themselves ever more boldly. And everywhere, between the green slopes or the reddish-yellow peaks, is the blue-white shimmer of the sea. Loftier summits block the horizon.

Now my gaze wanders over the innumerable inlets and headlands and ridges of Nictheroy, and steeps itself in the blue Guanabara Bay. Islands emerge, now here, now there; in the far distance one still sees the gleam of water, until it merges with the land that extends to the foot of the misty, jagged wall of the distant Organ Mountains. —Now I turn my eyes to the other shore of the bay. Rio, the great city, with its white houses, winds along the water's edge, climbs the rounded hills, breaks against the cliffs, leaps over them, and ends by climbing the spurs of Tijuca and Corcovado until it reaches the green forest that clothes all the crests and ridges. Defiant, rugged heads of rock peep forth from the green-clad slopes. The further the glance travels, the more menacing the hills become; more and more adventurous are the geological formations, one exceeding the other in boldness of outline; the law of gravity seems annulled for these overhanging tables of rock and leaning pinnacles.

Behind the mountains the sun is sinking. The ranges turn into dark corridors, behind which an orange-red flood of colour flames to heaven. Range divides itself from range as a whitish mist settles between them like a vapour from which worlds come into being. All shapes assume an incomplete and primeval quality.

On the other side the shadow of the Sugarloaf, after creeping mysteriously across the bay, is climbing higher and higher up the hills on the opposite side of the entrance. All colours fade; the darkness is falling.

And then, a sudden flash far below; a row of lights flings itself along the shore; a second row joins it; by fits and starts the ever-lengthening chain of lights progresses, as though each kindled its fellow. Suddenly there is a flash from the water-front of Nictheroy, and the rows of lights run onward till they reach the ocean. The pearly necklace is closed; and now the land receives a star-spangled garment.

But the signal for the last trip down is sounding. In the silence of the night the car swings downward, sinking ever nearer to the glittering carpet beneath it. Above, as below, is an ocean of stars. One feels that one has taken leave of reality; it is as though one were floating in the pure ether of space.

II

THE OCEAN SHORE

On all the shores of the tropic seas the coconut-palms bow in the wind.

A lovelier background for the breakers seething on the beach cannot be imagined. For the coconut-palm is like a child of the ocean. The bluish-green of the crown of gigantic leaves is in tone with the sea, and as in the many-hued sea one colour flows into another, so it is in the leafy crown of the coconut-palm, as the sunlight plays upon the leaves; now the yellow of the ribs predominates, now the dark green of the leaves in shadow, and now the vivid green of the sunlit foliage; and the white foam-crests of the breakers find an echo in the flashing lights of the glossy upper surfaces of the fronds (Plate 8).

The movement of the waves and the soughing of the trade-wind are repeated by the lofty shafts, each of which leans at a different angle, and in the incessant play of the graceful fronds one seems to hear an echo of the crashing breakers. It is as though the strings of a harp were vibrating in sympathy with the seething of the ocean.

Of our own trees those that remind me most of the coconut-palms are the pines, familiar to me from my childhood, that sigh and rustle on the dunes of the Baltic. They too have tall, bare trunks, which glow in the evening sun. This memory endeared the coconut-palms to me when first I encountered them in Ceylon. It was not until I went to Brazil that I fully realized the beauty of these trees; I was never tired of gazing at the palms, and delighting in their noble bearing. And this example taught me that the beauties of Nature are disclosed only to engrossed contemplation; many a traveller finds fault with things that he would be as ready to praise had he the time and patience and energy to consider them more thoroughly.

Even in its mode of propagation the coconut-palm is adapted to the sea. The nut, as large as a man's head, is enclosed in a brown husk, and under this is a dense layer of fibres, which serves as a sort of lifebuoy, in which it may float far oversea without being injured by the force of the waves. For the real nut lies embedded in the fibrous husk, and itself consists of a thick and very hard shell, in which three holes may be perceived, and a kernel. Two of these holes are overgrown; beneath the third lies the germ of the nut. From it the white substance of the nut spreads over the inside of the shell, forming a lining as thick as the finger; this is the nourishment provided for the germ (the endosperm). When the nut is unripe the layer of fibres is still white and the hard shell as yet unformed, and then one can slash a hole in the husk with a knife, and pour out of the nut from half to three-quarters of a pint of a cool, almost clear liquid, which has a sweet, nutty flavour. This is an admirable and wholesome beverage, and there are coconut-palms which are cultivated merely for the sake of this liquid. As the nut ripens the liquid becomes oilier and milkier, and less abundant, so that an air-space is left, which would enable the nut to float even without the husk. It is in this state that the nut is imported into Europe, and the admirable beverage yielded by the unripe nut cannot be compared with the remnant of "milk" left in the nuts as we receive them.

If the floating nut is cast upon the shore, the action of the sea-water and the pounding of the breakers destroy the fibrous husk. The germ pushes forth into the heart of the nut a special suctorial organ, by means of which it draws building material from the hollow kernel and water from the "milk," and this fresh water, which it could not find upon the beach, is of great importance for the embryo tree. Then the germ grows outwards from the hole in the shell, and in course of time becomes a palm-tree, which after five years begins to bear more nuts, and continues to bear them up to its seventieth or eightieth year.

Where was the first home of the coconut-palm?—We are not yet quite certain. According to Warburg, it should be sought in Central America, for in Panama there are still extant virgin forests of coconut-palms. Crossing the Pacific Ocean, it seems then to have colonized Polynesia, Southern Asia, and finally East Africa. It is believed to have been first planted by man in South Africa and Brazil, though there are investigators who believe that the palm is indigenous to Brazil, and the Dutchman Laet, two hundred years after the discovery of Brazil, reckoned it among the wild trees which were found outside the cultivated areas, and in regions remote from the villages of the Indians. And it was only about this period that the nut-bearing trees of the Old World were imported into Brazil.

The coconut-palm is to-day ubiquitous on the Brazilian coast as far south as the State of Espirito Santo, and in small numbers, or singly, it is found even farther south. But extensive coconut plantations, such as I saw in Ceylon, do not yet exist in Brazil, nor is this serviceable palm-tree exploited in a wholesale fashion. In India, not only are the dried kernels collected as copra and pressed in order to extract the oil, but an oil is prepared even from the fresh kernels, which solidifies at a temperature of 79°, and reaches Europe in the form of coconut butter. Arrak is manufactured from the sweet sap which flows from the severed flower-spathe, and the fibres of the husk (coir) are employed in the manufacture of nets, mats, hammocks, etc. The timber of the trunk, which grows to a height of ninety or a hundred feet, is employed in house-building, while the huge leaves, which are so heavy that it is difficult to lift even a single one, are employed as a roof-covering. On the coast of Pernambuco I saw only one large coconut plantation in the south; and another was situated to the north of Recife.

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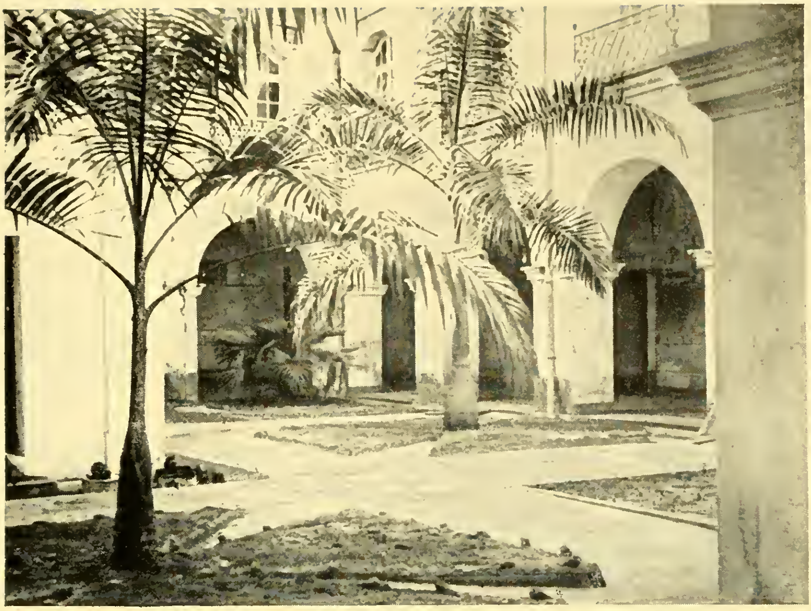
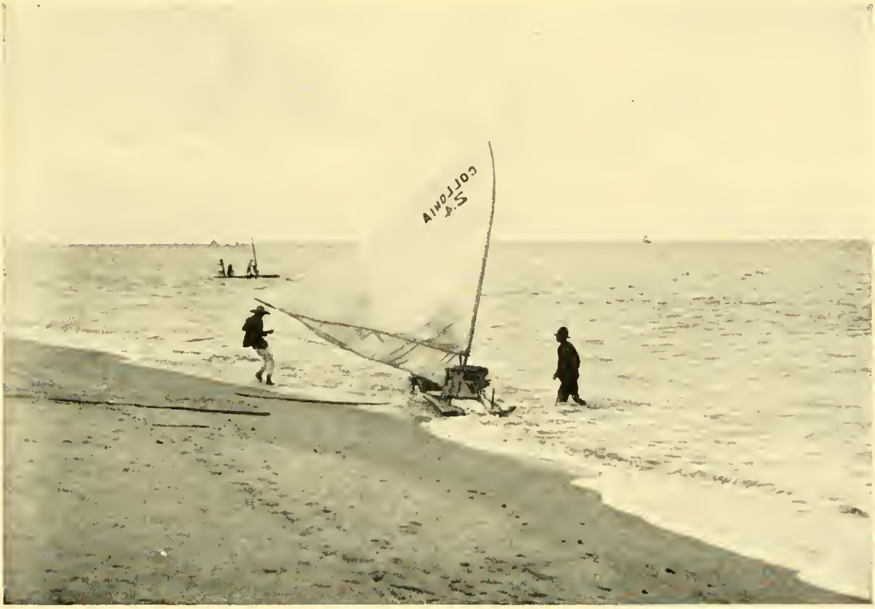
If one trudges up the sandy escarpment of the beach of Pernambuco and makes one's way between the shafts of the groves of coconut-palms, one comes, as a rule, to a dense wood, springing from the sand, in which cashew-trees are in the majority (Plate 9). The large oval leaves of these trees are bright green, with yellow ribs; the younger leaves have a reddish hue, but all alike are thick and leathery in texture, and have the glossy upper surface which is common to the foliage of most of the tropical trees. But the light, rather bluish green of the crowns of the cashew-trees in such a wood is especially beautiful, and if one looks along the coast from one of the hills about Olinda, the emerald sea and the yellow sand, bordered by the coconut-palms of the dunes, and behind them the expanse of light green foliage of the cashew-trees, make up a most cheerful and harmonious scene.

The fruit of the cashew-tree is peculiar. It consists of two parts, a pear and a kidney-shaped nut which hangs beneath the pear (Fig. 1). The pear, which when ripe assumes a reddish flesh-colour, has a sour-sweet flavour not unlike that of an apple, but it draws the mouth, being rich in tannin. It is prudent to suck this uncommonly juicy fruit in one's morning bath, as the juice, if it falls on one's linen, leaves an indelible stain. When one has sucked it only the skin is left, but hanging from the skin is the nut, which is, of course, the actual fruit, for the pear is only an enlargement of

PLATE II



CLOISTERS OF THE BENEDICTINE MONASTERY IN OLINDA



JANGADA (CATAMARAN) ON OLINDA BEACH

the fruit-stalk, whose function is to store water. The nut, which is sold by pharmaceutical chemists under the singular name of "elephant-louse," is thrown on an open fire, when a noxious oil is given off in vapour, with a good deal of crackling and puffing The nut then tastes like a roasted almond. The fruit can be made into one of the most delicious jams imaginable.

If one enters the bright green thicket of the cashew-bush, picking one's way between the trees, which rise up from the sand, or creep along the ground, lifting their boughs into the air, one may often encounter the most charming little monkeys—the Saguim or Silk Monkeys. In sweeping trajectories these graceful little creatures swing themselves from tree to tree, running along the boughs, or coming to a standstill on the trunk in order to nibble the rind of the tree, which exudes a sort of gum. At first sight these monkeys are not unlike dark brown cats, especially as their long tails are banded like the tail of a tabby, but if one approaches them closely one suddenly sees a dusky little face with round, anxious eyes; and the European, unaccustomed to monkeys in his native woods, is startled by these little gnomes with their human countenances (Plate 30).

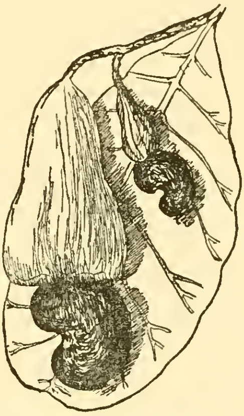


FIG. 1.—Two fruits of the Cashew-tree, on leaf (*reduced*)

Over the ground scamper grey lizards, known as Keel-tails, because the scales of the tail are furnished with a keel. These creatures are very common everywhere; they sit on the stone-heaps in the streets of Recife and Olinda, disappearing into the chinks as one approaches, but they soon reappear, and nod their heads repeatedly as though in derision. The Keel-tails are very alert, and have excellent sight. I have seen one of them detect a worm on the ground from a height of fifteen feet; down it came, in little sudden rushes, and devoured its prey. All their movements are vivacious; and the rapid nodding of the head adds to the general impression of an absurd and laughable nervousness. I used often to watch them from my window in Olinda. They were forever at the pear-trees, to the indignation of the Brothers who tended the garden. There were frequent quarrels; one would rush at another and bite him, and on such occasions they lashed their tails to and fro, either in menace or in self-encouragement.

Apart from the monkeys and lizards there is not much life in the cashew-bush. Now and again birds flit through the tangle of boughs, or a locust, as long as one's finger, suddenly takes his rustling flight. It is delightful to watch the glittering humming-birds if one takes one's stand before a tree which is enveloped in the strands of a passion-flower and hung with the lovely blossoms, with their delicate white and violet veining; for, as we shall read in Chapter V, the passion-flower or Maracujá is fertilized by these beautiful little birds.

The Paternoster pea provides another lovely spectacle. It blazes in the shadows of the bush like a fiery red eye with a black pupil; the bright peas glitter in the open pods of the creepers, and falling to the ground, gleam like beads of coral. These beautiful peas are threaded into rosaries, or glued upon shell-covered boxes. Handling them, however, is a dangerous occupation, for the peas contain a poison (abrin) of which a small dose is fatal if injected under the skin.

One may wander for hours through the cashew-bush of the coast of north-eastern Brazil without encountering a sign of the presence of man. Then, perhaps, one comes to a track which has been trodden by horses or cattle. One follows it, and suddenly one comes to the dead body of a horse, lying on the sand, and with a rustling of wings a number of black Urubú vultures rise into the air, which have literally flayed the carcase. Now the ground sinks, and a water-course, running through green meadows, collects in a basin. In the centre there is a glitter of water, but elsewhere the basin is filled with a dense vegetation. The plant whose light-blue spires of blossom nod above the tangle of leaves is the "Water-foot," or Eichhornia. Water-fowl, orange and hyacinth-blue coots, go about their business in the thicket of leaves.

Behind the pond is a meadow. Here is a path, enclosed by barbed-wire fencing, whose wooden posts are perforated by the steely-blue Carpenter-bee. Along the fences are dense clumps of the great Brazilian nettle. One must be careful not to touch the three-lobed leaves. Compared with the burning irritation which they cause the sting of our nettle is a mere tickling.

Now a negro hut appears, thatched with straw; before it a black, naked little boy is playing. Macaiba-palms, whose trunks are dilated like spindles, and whose great fronds have a grass-like appearance, overshadow the hut, and a few oil-palms stretch their spiky leaves into the air, revealing, under their crowns, their clusters of glowing orange fruit (Plate 9). We pass the hut, and again the bush closes around us, until we come to a thin hedge of coconut-palms, beyond which lies the sparkling sea.

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Here on the seashore, under the palms, amidst the dead fronds and fragments of husk that crackle beneath our feet, a little reddish flower blooms, which resembles our bindweed; it belongs, indeed, to the same family. It is the Goatfoot Bindweed, which is widely distributed on all tropical coasts, as the seed survives long immersion in salt water; I had seen it already in Ceylon. Another flower of similar form holds up towards the sun a bright yellow blossom, whose interior is a warm orange, with a fleck of darkest violet at its heart. It opens always at nine o'clock in the morning, so that the Brazilians call the plant "Nove Horas"—or even say "relogio" for "nine o'clock." One finds this pretty little flower also between the rails of the electric tramway in Olinda.

And now once more we are on the beach, and the sea glitters green; little pale sand-crabs scuttle away before us, and when they hurry sidelong across the sand they look like empty shells driven by the wind.—There are few shellfish lying on the beach; but yonder shines a blue transparent bladder, shimmering like glass, almost as large as a man's fist. Its shape is like that of a three-cornered hat; as though seeking the water, the pointed end gropes to and fro, while the bladder alternately dilates and contracts (Fig. 2).

It is a marine animal, cast up by the sea; the Physalia, a species of Hydromedusa. The Brazilians call it the Caravella—which means a little ship; the English name is the Portuguese man-of-war. And the Caravella really does float upon the water like a little ship of glass. I used often to put one of these creatures into a glass of sea-water, and I was never weary of marvelling at its glorious colours. Now light blue, now violet, now silver the crystalline creature shimmers, and still further to enhance its splendour the top of the bladder is traversed by a crimson comb. From the underside of the bladder depend long filaments, which seem to be spun of glass of the most glorious ultramarine blue. Silently they contract and extend themselves as the bladder dilates and subsides.

The Caravella is not a single individual, but a whole colony of polyps. The polyp is a primitive organism whose intestine is a simple sac, having only one orifice, through which nourishment is absorbed and undigested matter ejected. In the Caravella quite a number of such tubular polyps depend from the bladder, which keeps them afloat, and into which a special gland allows gas to enter, inflating it like a balloon. Between the short tubular polyps which absorb nourishment (Fig. 2, S), longer polyps hang down like fine tentacles, whose function is to capture tiny crabs and fishes and convey them to the orifices of the polyps or *siphons*, whose function it is to absorb and digest. For this purpose they are equipped from top to bottom with batteries of explosive cells or *nematocysts* which expel extremely fine filaments, and thereby inject a poison into any little fish that swims against them. The fish is immediately paralysed and remains fastened to the tentacle, and this winds itself about its prey, and conveys it, by progressive contraction, to the siphons, which absorb and digest it. These little capillary poison-fangs will penetrate even the human skin; if one touches the Caravella a sharp burning pain is felt. In the case of a large, freshly-taken Caravella the burning may be so acute that inflammation and fever will supervene.

With long drooping tentacles and bladder driven by the wind, the Caravella sails the seas, dredging the waters as with a net that paralyses and kills all living things. Despite the terrible poison-batteries, however, certain little fishes have adapted themselves to this sinister creature, and are found constantly swimming in among the tentacles; they are protected against many of their enemies by this formidable screen, and at the same time they flourish on the leavings of their living entanglement.

The polyps of which the Caravella is a living colony are found also as individuals in a profuse variety of forms. On the floor of the sea there are individual polyps which are similar in structure to the nutritive siphons (gastrozoids) of the Caravella, and which live with the closed end of the digestive sac adhering to the sea-bottom; with the mouth-orifice extended upwards, they capture with a circlet of tentacles such creatures as swim within their reach. The wanderer on the beaches of Brazil will not see much of these often resplendently coloured "sea-roses," unless he gazes into the depths of a calm, rocky bay. But there are also natatory forms of hydrozoa. The jelly-fish, sea-nettles, or Medusae are bell-shaped animals which pump their way through the water, rhythmically contracting the rim of the bell. From the circumference of the bell hang tentacles, which, like the snakes of Medusa's head, trail after it writhing and crinkling (Fig. 2). From the centre of the bell the mouth protrudes on a stalk, surrounded by broader pennon-like tentacles. These convey the prey which has been paralysed by the stinging-organs to the mouth, which passes them on to the stomach. The Medusae, like the Caravella, are transparent as glass, and often display the most delicate colours. I once saw whole shoals of them lying on the beach of the Praia Grande at Santos, the milky discs glittering like jellies in the sun.

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The profusely-peopled world of the fishes of the sea is commonly invisible to the human eye. But when the traveller, voyaging from Europe, approaches the Equator, he will see fish springing out of the water on either side of the ship, flashing silver in the sun, flying over the ocean with fins that have been transformed into wings, and disappearing, with a little splash, into a distant wave. These are flying-fish, about the size of a herring, which leap out of the water to escape the predatory fish that are pursuing them, and are now frightened by the ship. How often I have watched their swallow-like flight on the Indian and Atlantic Oceans! But the flying-fish are creatures of the high seas; one does not see them from the beach. If the landsman wishes to see fish he must go down to meet the fishing-boats and inspect their catch. In addition to the fish, great and small, which one may meet again on the table in the form

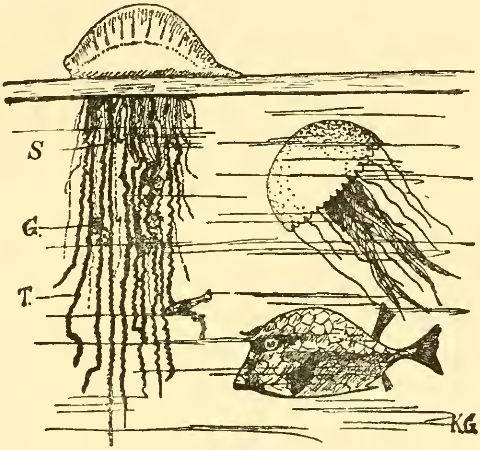

FIG. 2.—On the left, the Caravella or Portuguese man-of-war (Physalia). Above the surface is the swimming-bladder or pneumatophore. S, siphons; T, tentacles and palpacles; G, genital organ or gonostyle.—On the right, a jelly-fish (Pelagia). Beneath it a Coffer-fish (*reduced*)

of a savoury dish, many strange and monstrous creatures catch the eye.

For example, there is the Coffer-fish, whose body is built on rectangular lines, like a box; the belly is flat as a board, and the sides too are flat; and the belly ends in a mouth from which a flat vertical forehead rises. Thus the fish is like a little box, and its body is encased with hexagonal plates of bone, which increase its rigidity. The little tail, lashing quickly to and fro, and the protruding eyes, above which are two forward-pointing spines, form a comical contrast to this rigid body (Fig. 2).

Facing Rio across the bay is Nictheroy. Here one may wander along the fine highway that skirts the waterside, ending in the wide sandy beach of the Praia Icarahy, unable to turn one's eyes from the spectacle of the hills of the opposite shore, with their rugged forms, tilted peaks and boldly projecting promontories, looking as though the hand of an artist had painted them on the background of the blue sky.—Rounding a promontory as green as a garden, one overlooks a quiet, hill-girt bay. At the foot of some projecting rocks lies a white house with a large roof and arcaded verandahs. This is the Brazilian Yacht Club, of which the members are mostly German. Round about it the sailing-boats lie at rest on the blue tide. Here I once spent a few days; diving from the long wooden jetty into the clear, deep, refreshing water, or sitting on the wall and gazing toward the mouth of the bay, where the mountains rose in a bluish vapour against the sky.

But if I went through the terraced garden, and descended some narrow steps that were flanked by flowering bushes, I came to a basin filled with sea-water, lying against the sea-wall, on the other side of which the waves broke with a gentle splashing. I delighted in watching the fish that swam to and fro in this basin. The Coffer-fish, a slow swimmer, was easy to catch, but if one took it out of the water it inflated itself. A relative of the Coffer-fish, the Hedgehog-fish, is even more expert in this art. Its whole body is covered with spines; hence its name. If as it swims through the water in search of its food the Hedgehog-fish is attacked by a predatory fish it quickly pumps its stomach full of air; the elastic abdominal wall dilates; the fish, now spherical in form, shoots up to the surface, and there capsizes, as its back is heavier than its belly, so that the pursuer is confronted by a forest of rigid spines, and is quite unable to deal with its suddenly transformed prey; it cannot get a hold of this prickly ball, nor can it take such a monstrous titbit into its mouth;

moreover, the angry Hedgehog-fish lashes out with its tail, trying, not without success, to wound its enemy. When the danger is past it expels the air with an audible hiss, sinks into the depths, and swims contentedly away.

It was fascinating to watch the fishes that suddenly shot forward from the dark recesses of the basin if I threw in a small fish or a rock-louse (which the Brazilians call the *Barata do mar*, the sea-cockroach; they may be found anywhere along the shore, scrambling about over submerged stones). As the Barata splashed into the water, flat, vertically-swimming fish striped with black and yellow darted forward; and then the Parrot-fish or Slinger made its appearance. This fish, as large as a plaice, is so luminously coloured that you might think it had swallowed a Bengal fire. The body is brown, but the belly gleams with the deepest violet, while the back is striped with blue, and blue stripes run backwards from the mouth. Near the eye itself are zigzag lines of blue, like flashes of blue lightning. The pennon-like dorsal and abdominal fins and the beautifully shaped tail are also streaked with blue and violet.

This fish soon seemed to realize that I used to bring it food. Hardly had I reached the basin, when the two Parrot-fish which inhabited it came to the surface and lay on their sides, their resplendent colours blazing in the sun, making the water swirl with their pennon-like fins, and spouting long curving jets of water from their beak-like mouths: all to attract attention to themselves. And as they swam about the surface thus their protruding eyes were continually turned upon me, which gave them a droll appearance, as though they were roguishly winking at me.

In the "Passeio publico," the public park of Rio, is a little aquarium, admission to which is free, and here one may observe a number of tropical fish, including the singular Bat-fish, whose shoulders protrude right and left like a couple of pointed stakes, bearing on their tips two fins like little banners. Here too are crayfish and garfish, the savoury "Camarões," and some fine turtles. And one may with luck see at least the head of a turtle in the calm, rock-bound Turtle Bay of Guarajá, near Santos.

Off the coast of Pernambuco and other north-eastern States, and even in the harbours of Recife, Maceió and Bahia, one may often see sharks, for these creatures prefer to swim near the surface, so that the triangular dorsal fin emerges from the water. While I was in Pernambuco I was told, by several persons, the following story: As a steamer was about to leave Bahia, and the passengers were crowding on to the gangway, a child fell into the water. In a moment a shark shot forward, seized the child, and dragged it under the water. There was a terrible shriek from the parents; then the child reappeared, but bathed in blood, and legless; and now the unhappy parents themselves begged that it should not be rescued, so it sank again before their eyes.

I myself witnessed neither this nor any similar scene, so that I cannot vouch for its truth. But here is something which I have seen. As our steamer lay in the Bay of Aden a number of large sharks were swimming around it in search of refuse, but their presence did not prevent the pretty little Somali boys who had come out in their boats from exhibiting their skill in diving after coins which were thrown into the water. Similarly, the South Sea islanders are said to swim fearlessly in the near neighbourhood of sharks. The explorer Pechuel-Loesche, during more than twenty years of travel, never saw anyone killed or injured by sharks, nor could he ever discover a reliable eye-witness of any such incident. One is therefore obliged to conclude that the shark cannot be as bad as its reputation. Fiction, especially if it is written for juvenile readers, is apt to exaggerate the dangers of encountering animals, as the writers foolishly imagine that an animal cannot interest their readers unless it steals, or kills, or is killed.

I fancy the lion and the tiger have been almost as much maligned as the shark. As a general thing these beasts of prey avoid human beings; but now and again it happens that an old animal whose teeth are defective, and who can no longer capture wild animals, sinks to the degenerate practice of lying in wait for human beings. But it cannot be disputed that there have been fatalities due to sharks, and here again it seems to be always the solitary and outcast shark which becomes a man-eater. Jack London, writing of the South Seas, calls such man-eaters tiger-sharks; but the great majority are content with fish. The man-eaters are great travellers, and have been known even to swim through the Suez Canal and to work mischief on the shores of the Mediterranean.

There is also, on the coast of north-eastern Brazil, a fish of the Mullet family, the Picuda, which is sometimes as much as six feet in length, and which is said to enter harbours and to seize and devour bathers. This fish is sometimes caught by the fishermen, but its flesh is said to be poisonous at certain seasons.

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Now and again one sees a whale off the north-eastern coast of Brazil, and near Cabedello, the harbour of Parahyba, a whaling station has actually been established; so that this much persecuted animal, which is slowly nearing extinction, will presently be lost to Brazil. The lesser relatives of the giant mammal (for the whales, of course, are not fish, but warm-blooded animals which breathe with lungs and suckle their young), the dolphins, are familiar to everyone who has crossed the ferry from Rio to Nictheroy. The waters of the beautiful bay wake to sudden life when the pointed fins and black backs of the dolphins emerge, describing a graceful curve, tilting over, and disappearing. The dolphin at home in the harbour is the tide-water dolphin or Boto.

While the eye is still following their glistening black bodies a sudden splash is heard, and something falls into the water like a stone. It is a gannet, a large bird with a long straight beak, which dives from a height in order to seize its prey. Its colleague, the handsome frigate-bird, is usually seen hovering high in the air. I had already admired these birds in Bahia. The forked tail produces the illusion of two long legs outstretched behind the bird, so that at first sight I thought it must be a stork or crane.

When, sailing from Santos, I approached the vast estuary of La Plata, I experienced a treat which I had not looked for on this voyage. Though the month was July, the air was cold as winter, and I paced the deck shivering, wrapped in my warmest cloak. Then, suddenly, my attention was attracted by a sharp muzzle which lifted itself from the water, followed by a narrow head; and then two great round eyes were staring at the ship. Other heads appeared; they were the heads of sea-lions, Antarctic animals. We saw them for a time constantly; there were young cubs among them, which rushed through the water like fish, hastening away in terror, with outstretched flippers and hunched backs, from the great steamer. Near the Isla de Lobo (Sea-Lion Island), which rises from the sea not far from Montevideo, there were so many sea-lions sitting on a reef that their lifted heads gave it a serrated appearance, and at night their expressive roaring sounded over the water. There were penguins too swimming in the sea, birds of the Antarctic Ocean, whose wings have turned into scaly flippers. The black and white bodies lay horizontal on the water. The third inhabitant of the southern hemisphere which I encountered was the albatross. Without a movement of their wings, the albatrosses floated lightly to and fro behind the ship, their brown pinions outstretched from their white bodies like the balancing-pole of a rope-walker. On the return voyage in September the ship was accompanied also by Cape pigeons, which flew constantly above the ship's wake, stooping after scraps of food. They are called pigeons because they resemble those birds in size, and in the shape of the bill, but in reality these pretty creatures, with their black and white harlequin costume, belong to the Petrels. They breed on the coast of Uruguay, and on Tierra del Fuego.

Now and again one sees plovers on the beaches of Brazil, or sandpipers, small brown birds which run swiftly to and fro on their slender little legs. Seagulls, which the Brazilians call "Gaivotas," and terns, "Trinta rais," I seldom saw. These birds are more numerous on our German islands in the North Sea, particularly where they are protected. Since the terns, and some of the gulls, lay their eggs on the sand, where anyone may steal them, the collection of these eggs by the natives may be the cause of their comparative rarity on the inhabited stretches of the Brazilian coast.

In October 1924 the Deutsche Wirtschaftsdienst in Berlin reported that the seal fishery in Uruguay had become an important source of revenue. In 1922, an especially good year, 2,600 fine and 4,000 ordinary skins were obtained. One Argentine company obtained 5,000 barrels of seal-oil and 30,000 of train-oil, and the whale fishery on the whole of the coast was said to have yielded 77,000 barrels of train-oil. Fortunately for the seals, a Uruguayan commission has recommended a statutory regulation of the seal fishery, and Argentina too is said to have established a close season, so that we may hope that these beautiful creatures will not be recklessly sacrificed to the greed of gain. The whale fishery, on the other hand, will soon have cleared the southern seas of the giant mammals, as it has already cleared the northern. Here only the strictest legislation would be of avail, and it would have to be enforced by international supervision; and experience seems to show us that the nations are as yet unready for such measures.

As our vessel was approaching Santos from the south, we saw dead penguins floating on the water. As long ago as 1899 H. von Ihering reported such a wholesale mortality of penguins, albatrosses and gulls. In 1920, moreover, hundreds of penguins are said to have been washed ashore near Santos, and since then such regrettable mortality has frequently recurred. H. Luedervaldt, of the São Paulo Museum, is of the opinion that the larger seabirds are exhausted by protracted gales, because in rough weather the fish seek the quiet depths, and can no longer be caught by striking or diving; and in warmer latitudes a sudden change of temperature might be fatal to the penguins.

This opinion I cannot share. While such circumstances might be fatal to individual birds of a weakly constitution, I do not think they could ever threaten the existence of a whole species. They would, on the contrary, have a selective action, inasmuch as the weaker birds, and those whose instinct did not warn them against wandering too far north, would be excluded from perpetuating their species. Animals have always adapted themselves to natural occurrences, and there have always been gales; yet sailors who have visited the yet unexplored regions of the Antarctic invariably speak of the indescribable profusion of sea-birds in those latitudes. The penguins first began to grow rarer when men began to stamp them down in barrels in order to extract their oil, and the albatrosses when men began to plunder their breeding-places in the Pacific, stealing their eggs, and killing the birds themselves—which, on their lonely islands, were unaccustomed to the presence of enemies—in order to adorn women's hats with their feathers.

I have no doubt that the cause of this wholesale mortality of sea-birds is that which has killed so many round Heligoland. The oil thrown overboard by steamers which burn oil fuel spreads over the surface of the water, and the birds alight on it, or swim through it, as the penguins do; their feathers become matted together, so that they can no longer keep the water from their skin, with the result that they catch cold and die. Thousands of lovely birds perish in this way, and unless some device is soon invented which will prevent the discharge of such oil, and unless its use is made compulsory by law, the seas will one day lie dead in the sunlight: they will have lost their living beauty.

Man to-day is terribly estranged from Nature, to his own detriment, for he thereby loses much of the joy of life. Perhaps the steamship companies might be induced to intervene on behalf of the sea-birds, for it is obviously to their advantage that a sea-voyage should be as interesting as possible. For after a week or two at sea the grey spectre of boredom makes its appearance, and as time goes on deck-sports and dancing no longer suffice to dispel it. It has always been my experience that everyone wakes up at once the moment a whale is sighted, or when a rare sea-bird is seen to be following the ship.

Just as watering-places anxious to attract visitors are careful to preserve the beauty of the surrounding country, so, as the fully-justified conviction gains ground that few things are more refreshing to the body and beneficial to the health, care should be taken to ensure that the passenger is kept cheerful and amused. This can best be done by providing him with exciting and interesting experiences. For his own sake, and for the sake of the future, man should see to it that the life of the sea is preserved. For just as a forest does not consist of trees alone—just as flowers, and the song of birds, and the glitter and hum of insects are inseparable from its individuality—so the sea is more than mere water. Its living inhabitants, from the sea-anemone and the starfish on the rocks to the fish that swim in its waters, and the seabirds that glide above its waves, are all part of the sea; they are all interrelated, like the several parts of a work of art; they are mutually dependent on one another for their existence, and only in the harmonious co-existence of all its elements can the whole prosper. Only thus can the sea exert that invigorating, enriching and uplifting influence upon the human soul which all the world over makes Nature the best physician and teacher of mankind.

III

THE SCAVENGERS OF THE SHORE, AND THE MANGROVE WOODS

THE sea is an eternal grave. At every moment dying creatures are sinking on to the floor of the sea, where innumerable living creatures set to work upon their corpses. What cannot be utilized is covered by the gradual deposition of the fine ooze which the rivers bring down to the sea.

The bodies of other creatures, which perish near the coast, are cast ashore by the sea. For a long while the ocean plays with them as though reluctant to surrender its booty; it draws them back, and again washes them forward with its breaking rollers, until at last some greater wave casts them so high upon the beach that those which follow are no longer able to reach them.

And there the dead fishes lie, with here and there a drowned mammal, and the high-water mark would soon be a line of putrefying corpses, had not this coastal cemetery its own living sextons. Hovering high in the air, they spy, with their piercing eyes, the smallest of these dead creatures, descend upon it with rustling wings, and smite their beaks into its flesh.

These sextons are the black vultures or Urubús, the characteristic tokens of the Brazilian coast, and the voyager from Europe rejoices to see the heavens alive with these great birds—for they are as large as a turkey—cruising in majestic circles. I have seen them in a coastal thicket, at work on the carcase of a horse; I have seen them on the beach at Santos, drying their outspread wings in the morning sun; they came marching up from the water in long files, turning their narrow heads, which seem too small for their corpulent, black-plumaged bodies, to gaze at me as I drew near, though they did not allow themselves to be perturbed. And often I saw them floating like black shadows between the glittering fans of the coconut-palms (Plate 10).

Even in the interior of the country I saw them frequently, and at Caruarú, a little town eight hours' journey by rail from the coast, I saw their nesting-places on the high rocks. In that country, where people simply throw their refuse, and the carcases of animals, into the nearest thicket, it is the vultures that prevent the air from being poisoned and breeding pestilence. For this reason they are not molested; though, to be sure, their flesh would not be very palatable.

There are several species of Urubú; one, the Raven Vulture, has a dark head; another, the Turkey Vulture, has a red head, and there are also some whose heads are yellow. Brazil boasts also of a very large "Urubúrei," who fully deserves his name of King Vulture, for the plumage of the body, white over pale rose, the jet-black pinions and rump, the bright red of the neck, and the tubercles on the beak, have a truly regal appearance. This bird, however, is rare, and I saw only specimens in captivity. The largest of the vultures, the Condor, is found on and about the snow-covered peaks of the Andes.

Vultures need bare expanses of land—meadows, deserts or sea beaches—for they must be able to see the dead animals which constitute their nourishment; in wooded country the ground is of course invisible. In Aden I saw the Indian carrion-vultures which are found there, sitting all over the naked rocks of the valley, basking in the sun. There they were allotted the task of devouring the corpses of the Parsees in a "Tower of Silence," for the ancient Persian religion requires the Parsees to dispose of their dead in this manner. In Ceylon, on the other hand, which is largely afforested, there are no vultures.

The Urubús swallow their food in great mouthfuls, and the larger the carcase the better they like it. They do not touch the smaller fish, crustacea, and molluscs cast up on the shore; for these Nature has appointed another body of scavengers.

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If I sat on the beach at Olinda, gazing at the bright green sea, while behind me the coconut-palms rustled, and the brine-scented wind blew into my face, and kept perfectly still, certain phantom-like little creatures emerged one by one from the sand. From all directions dark and curiously dead eyes turned themselves upon me. I was surrounded by spectres. They were sand-crabs, creatures with flat, rectangular bodies and coloured like the sand. They had crept out of their hiding-places—deep holes which they themselves had dug in the sand—and now turned attentively in all directions their black, stalked eyes, which stood up like two little lighthouses. If I still remained motionless they began cautiously to move, slowly at first, and then more quickly, travelling sideways as crabs always do. If they found a dead fish, a scrap of wood, or one of the seed-pods of the bladder-wrack, which lay like green beads on the sand, they fingered them with their blue-white hands, their claws, plucked them to pieces, and conveyed them to their mouths, or dragged their booty to their holes, so that in case of danger they could disappear in a flash.

If I made the slightest movement they were in their holes in a moment, and it was some considerable time before they cautiously ventured forth again. To catch them was impossible; at least, I did occasionally succeed in doing so if I sat motionless by a hole, waited until the crab came out, and then, quick as lightning, flung a stone over the hole. Sometimes, too, when wandering along the shore, I caught a sand-crab who had ventured into shallow water in order to moisten its chest-cavity, for the sand-crabs, like all their kind, breathe through gills. The gill-chambers, which are enclosed by the shell, retain the moisture for a long time, and when the oxygen is exhausted the crab allows air to enter by a small aperture in the rear of its body.

If one disturbs the sand-crabs as they are wandering down to the sea they run at full speed back to their holes.—In Ceylon too I encountered sand-crabs; they were even more numerous than in Brazil, and less timid, and fled back before the pedestrian like a living wave. If they were brought to bay they reared up and lifted their claws in a threatening manner, and a dog which used to accompany me in Olinda did not dare to tackle so valiant an adversary, but merely snapped at the air, barking, and prudently keeping his distance.

It always amused me to watch the sand-crabs, and I never wearied of observing their apparently intelligent behaviour. I even kept them in the house, in glass containers filled with sand, where I fed them with insects. Here I was able to observe how the sand-crab digs his hole. He presses himself sideways into the sand, grasps a little pellet of sand with two legs and a claw, pulls himself back with the four opposite legs, and then flings the sand away with his claw. All this is done by jerky movements, and while the crab is at work he keeps a constant and cautious watch upon his surroundings. The hole, when finished, is so deep that one has to dig for some time before coming to the bottom. The sand-crabs of Brazil have certain relatives which live in a similar fashion, but grow to a much larger size. The body of the sand-crab is seldom larger than a five-shilling piece, but these other crabs are powerful creatures, and their claws are as big as those of a large lobster.

In the plains bordering on the sea, which are overgrown with mangrove-thickets, and are flooded at high tide, but at ebb tide show patches of black, slimy mud, these crabs are at home. If one travels from Recife to Olinda by the electric tramway, for the greater part of the half-hour's journey one passes through such a mangrove-swamp. The glossy green thickets extend in all directions, and between them are gleaming channels and occasional pools. Here and there, on islands which are joined to the road by causeways, are negro cabins of mud, thatched with palm-straw, before which girls or naked black little boys are playing, or black pigs and fowls are rooting or scratching in the mire. Behind them is the long, blue-green line of the sea; at one point an old Dutch fort rises out of the bush, with picturesque half-ruined bastions. The whole makes a beautiful picture, of which I was never weary, and the sea-breeze, blowing across the open benches of the tram, was always refreshing.

In the air hovered the black vultures, or they sat huddled on the black muddy islands. But these had other inhabitants also. There, before their holes, sat crabs of all sizes, cautiously looking about them with their black stalked eyes; for the negroes hunt them, and often offer the "carangeijos" for sale in the streets, when the unfortunate creatures are tied together in a long string.

For a long time I kept one of these swamp-crabs in my room. His colour was a splendid sky-blue, passing into yellow on the sides and the claws. He had one large and one small claw; the large right-hand claw was his weapon, and if I drove him into a corner in order to catch him, he struck at me so fiercely with this claw that his whole body was jerked forward by the movement. I believe this crab could easily have crushed one of my fingers with his pincers. I fed him with bananas, bread, or large insects and sand-crabs, which he promptly seized, pulling off all their legs in order to prevent their escape. Then, with vigorous tugs, he tore his prey to pieces, and ate the whole. If a crab or insect took refuge under his body, he groped under his belly until he had recovered his victim.

The swamp-crab soon knew his way about my room, and when I left him free to run about I had always to keep the door shut. If he found a little pool of water under the wash-stand, he dabbed at it with his small claw, which he used as a hand, and conveyed it to his mouth; if I poured water over him, he gurgled loudly, and lashed his feelers to and fro, in order to direct the water into the

TWO OF THE ISLANDS OF RECIFE — GOVERNMENT PALACE

HOUSE IN CAXANGA, NEAR RECIFE

gill-chambers. The eyes were then washed with the palps of the large mandibles.

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Around Recife the mangroves form only a bushy growth, for the large trees have long ago been felled, and even the copse-wood growing from the roots and stumps is continually cut; for not only does the mangrove yield a wood which is used in cabinet-making, but the bark contains as much as 40 per cent. of tannin. To the naturalist the mangrove is of peculiar interest, for this plant is "viviparous," and strange as it may seem to apply an expression which is commonly used of animals to a motionless green vegetable, the word is none the less justified.

The fruit of the mangrove-tree has the form of a little green pear, and while still in the pear the seedling sprouts from the seed, whereas in other cases the seed does not germinate until the fruit has fallen from the tree. The seedling even develops a special suctorial organ, by which it sucks nutriment from the fruit, and the plant continues to supply the fruit with this nutriment: a state of affairs which is really comparable to the development of the embryo in the body of a mammal. In the case of the mangrove the seedling grows bigger and bigger, stretches itself out, breaks through the lower part of the fruit, and finally hangs out of it, in shape like a thick bean, some sixteen inches in length. This apparent bean, however, is the stem of the young plant; it is already fairly heavy, and pointed at the lower end. At last the time comes when the fruit can no longer support it, when it falls out, plunges into the water, and rams itself into the underlying mud, all by virtue of its weight and shape. Thus the mangrove, although it grows above the water, is nevertheless able to plant its seedlings in the ground: a truly wonderful adaptation!—In a few hours' time the young plant has already begun to anchor itself in the mud by pushing out lateral roots, and can no longer be washed away.

Full-grown mango-trees are to be seen only here and there in the neighbourhood of Recife and Santos (Plate 10). On other parts of the coast, however, the swamp-forest is more nearly intact; I saw the finest trees on the frontier of the States of Pernambuco and Alagoa, at Tamandaré, on the Estiva estate. Here a fairly wide river flows down from the hills near by, forms a mangrove-swamp, and then turns aside, flowing back to the swamp some distance from the sea. The sea flows into this swamp, and its waters rise and fall with the ebb and flow of the tide.

In an old canoe, punted with long poles by two mulattoes, I navigated its dark waters. The tops of the great trees met far overhead; between was a tangle of hanging creepers, which met above the stream, forming a vaulted roof, the leaves, when the sun struck them, glittering with a light green or silver fire. The mangrove has stiff leaves with thick-walled veins and capillaries, in order that the moisture should not evaporate too quickly. If the evaporation were too rapid too much salt water would be drawn up to replace the moisture lost, and an excess of salt would injure the foliage.

With their mighty trunks the trees stood high on their roots as though on a foundation of piles, under which the black water lost itself in the darkness. The roots sprang from the trunk in vigorous curves, sometimes growing from the foot of the tree and sometimes half-way up the stem, so that they had to grow a long way before they could dip into the water.

The wood seemed to rest on elastic springs; close at hand one was astonished by the monumental solemnity of all this sylvan architecture, but at a distance the pile-work of the roots had the strange appearance of an open, grill-like wall beneath the forest. The roots were yellow beneath the sharply-defined horizontal line which marked the level of high water; above this the living scaffolding was grey, and in the sunlight which filtered through the foliage, here outlining a root or bough and there flooding one with light, the surprising solidity and the delicate ramifications of the structure were revealed. For on the mangrove, as on most of the trees of the tropics, the large, thick, oval, pale-green leaves are so sparsely distributed that the architecture of the tree is visible down to its slenderest twig.

Slowly the canoe glided forward. Here and there the leaves of water-lilies floated on the surface like green plates; and where the pile-work of the mangroves receded, leaving an open creek, the leaves of the "Water-foot" grew in a dense throng. Wherever I found this aquatic plant, which is very common in Brazil, I rejoiced to see its light-blue and whitish spires of blossom. But the leaf-stalks of the stout leaves, lifted to the surface by bladders, were equally fascinating. For not only do these structures function as floats to support the leaves, but the air which they contain in their loosely-woven tissues is of service to those parts of the plant which are buried in the ooze, for the plants need air to breathe, and mud and slime contain less air than clear water.

On the bank stood a brown heron. Through the bush the capybaras, the long-haired "water-pigs" of Brazil (Fig. 33), had trodden a path. Now the scaffolding of the mangrove-roots closed in on either side, and it grew darker on the water. From time to time a flight of bats flew by, of a species which has taken to catching fish for its livelihood; flitting with a soundless flutter of wings over the stream, and settling on a tree-trunk that slanted over the water. Along the shore two or three "Martin-fishers" accompanied us, flying up when the canoe approached them, with a flashing of blue-grey plumage, and alighting again ahead of us, with their long beaks pointing towards the water. Once, too, I caught sight of the Great Kingfisher, in his light-grey plumage and white collar, the head-feathers ruffling in the breeze.

Bemtevis flew along the shore, perched on a projecting twig, and looked at us inquisitively from eyes that were set in a black stripe, which gave brilliance to the white band above them. From a bough outstretching far over the water the long, woven, pouch-like nest of the Checheou hung suspended. And now the call of the bird itself was heard: a call of beautiful, flute-like notes, which suddenly gave way to hoarse, guttural tones. Now the bird was silent, and the Crested Oriole, almost as large as a jackdaw, flew over the water, the yellow rump gleaming golden. Slowly a Morpho butterfly came floating through the forest on its silken-blue, black-bordered wings. Suddenly one of the mulattoes pointed to the top of a tree, and there, sure enough, stiff and motionless as though hewn out of stone, was a grey beast as big as a cat, its long, black-banded tail wound half-way round the bough on which it lay. A serrated crest ran along its back, and a long pouch hung from its throat. It was the great Brazilian tree-lizard, the Leguan, which the Brazilians call the Chameleão. Unfortunately I could not prevent the men with me from firing at it. After the shot all was at first still; then, gradually, the hind feet loosened their hold, the long tail dropped, the forefeet relaxed their grip, and with a thud and a splash the creature fell heavily to the wet ground.

It was not long before another great tropical reptile showed itself. I saw it in the distance, lying on a sandbank like a weathered tree-trunk; then suddenly the creature slid into the water. It was a caiman, a crocodile, which the Brazilians call the Jacaré. And quick as lightning another caiman shot into the stream from the opposite side. We noted the position of one of these creatures, a splendid specimen, twelve or fourteen feet in length, which is large for a Brazilian crocodile, and sure enough, on the way back, as we quietly rounded a projecting thicket of mangrove-roots, I saw the great reptile lying close before me on a sandbank, a grey, warty, antediluvian apparition, its huge head pointing towards the land. It seemed asleep, and only when one of the men fired did it throw up its head, turn its massive body, and disappear into the stream, just in front of the canoe.

The incautious behaviour of the caiman surprised me, for in Ceylon I never came upon a crocodile which was not lying with its head towards the water, so that it could disappear immediately on the approach of a human being. The great armoured lizards have long been hunted creatures; wherever there are human inhabitants they are rare, and they survive only by living in concealment and observing the greatest caution.

Many people may consider that the extermination of a creature which is dangerous to man cannot be productive of harm. But such people think too lightly of the powers of the Creator; as though He would create any creature that did not fill its appointed place and adapt itself as a living member of the whole great community of plants and animals, so that it cannot with impunity be blotted out of this harmony without harmful consequences! Already observers in the southern States of North America report that with the progressive disappearance of the alligator the rats and poisonous snakes have increased in numbers, and are much more unpleasantly conspicuous than their former enemies. Alligators and crocodiles do not destroy human food, as do rats. They live principally on fish, which they stun with a swish of the tail and skilfully sweep into their jaws. But it must not therefore be thought that the fish are exterminated, or that man is deprived of a food-supply. In the jungle of Ceylon I had an opportunity of observing an outlying tank in which there were many crocodiles, but which nevertheless was swarming with fish. In an unspoiled state of nature the predatory animals do not exterminate their prey, for species is attuned to species in its mode of life and its powers of multiplication.

As for danger to human beings, the American crocodiles, and as a general thing the alligators and caimans, are not man-eaters. These animals seldom grow to more than twelve or thirteen feet in length, and even this length is rarely attained by any but the black caiman, an Amazonian species which has grown accustomed to man, so that it will come to his camping-place and snap up the scraps of meat that are thrown to him. Man-eating is reported only in the case of the two largest of the armoured lizards, the Nile crocodile and the great Indian crocodile, and even in the case of these species it seems that it is only individuals—as in the case of lions and tigers—which become man-eaters. I myself had reason to be convinced that the Indian mugger or marsh crocodile, which does not exceed twelve or thirteen feet in length, is, like the American species, by no means a formidable creature; for when I was in Ceylon my native companion continually urged me to shoot one of these creatures, so that he could haul it out of the tank, and it was obvious that he had not the slightest fear of being seized by the other reptiles. At the same time, a crocodile even twelve feet in length looks a very large and sinister creature, and I can understand that anyone unused to the sight of such reptiles, or unfamiliar with their habits, would naturally believe that they were dangerous.

Only when it is defending its young does the caiman attack. The reptile makes itself a nest of vegetable refuse, whose decomposition generates a high temperature and thus incubates the eggs. When American crocodiles have made savage attacks on man, they were always parent reptiles anxious for the safety of their eggs or their young. And, of course, the crocodile defends itself if brought to bay.

The hide of the South American caiman, which is found as far south as La Plata, cannot, like the hide of the North American alligator, be turned into leather. In South America, consequently, there are no crocodile farms, whereas there are alligator farms in Florida. But although the Jacaré of Brazil is commercially valueless, I do not believe the Brazilian exists who, with rifle in hand, could pass such a reptile without shooting at it; and in all probability it will not be long before the caiman has to be added to the long list of animals exterminated by the hand of man. Our grandchildren, for whom travel in remote quarters of the earth will be easier than it is for us, will see little more there than they would at home; such rare creatures as cannot adapt themselves to the machinery of civilization will have perished in Brazil as elsewhere. Man can tolerate only servile natures; masterful creatures which offer him a stubborn resistance, obey only their own natural impulses, and for that very reason possess beauty and fascination—such creatures he destroys.

The extent to which the animal world contributes to the comfort of mankind will be increased, but our souls will be the poorer. For in each one of us, no matter how completely his mentality may be subdued to the Age of Technique, there survives, buried out of sight, the longing for unfettered natural beauty, the nostalgia for the bygone age when man lived among the beasts as a child of Nature. For he was once encompassed about with an inexhaustible wealth of living forms, which, in his moments of inspiration, he explained in sagas and folk-tales. And these sagas, these long-vanished but not extinct experiences, wake to life when beside the dark waters of a forest stream we see, huge as a weathered tree-trunk, primeval of aspect, the dragon of the ancient world, the crocodile.

IV

THE VIRGIN FOREST

When we hear the words "the virgin forest" a green wilderness appears before our eyes, that reveals, far from the civilized world, only the still life and movement of majestic Nature. A boy's eyes glitter when he hears of the primeval forest, and a longing seizes him one day to explore this green dusk for himself.

On European soil, however, only the smallest remnant of the primeval forest is left. All the more, therefore, the imagination plays with the thought of the forests of other lands, of which the travellers bring us their reports. And in truth it is in the virgin forest that the mind avid of discovery will most surely attain the fulfilment of its longings. It is in the very nature of the untouched forest to be the guardian of secrets, and it has from of old been the refuge of those creatures which belong to an earlier period, and can no longer live their former life in a changed world.

Thus it was in the virgin forest that the okapi, the gorilla, and the pigmy tribes of the Akka found their last refuge. The Indian jungle gives shelter to the tapir, and the jungle of Ceylon to the dwindling race of the Veddahs. The last specimens of the European wild horse, which shortly after the glacial period trod the plains of Europe in countless herds, were killed in the forest of the Vosges, and the bison, which originally roamed the plains, became the forest aurochs. And when the Germans made their way up the Rhine and the Danube, and built their homesteads on the flanks of the hills, they often saw fires burning on the wooded heights above them. These were the fires of the dark-haired aborigines who had withdrawn before the great migration. Once they too had lived in the plains, and had built their huts on piles driven into the beds of the lakes. For the new masters of the land, however, they were the Albi, the wizards, who lived mysteriously in the dense forest, where in the deep ravines even the scaly dragon had his lair.

We can guess how the imagination was excited by such tales, and how many a boy would think that there could be nothing finer than to attempt a voyage of discovery into the wild forest. From those old days the *sense* of the primeval forest has survived in our minds; and it is this sense which is liberated by the spectacle of the tropical woodland. No one can get out of his own skin; even at the

Equator the European is still a European; at first he feels an alien in the tropics, and unrelated to tropical nature. And when he falls under the spell of the sublimity of the forest, it is his European soul that is thrilled and impressed, and all unknown to himself, the image of the primeval forest that dwells within him draws a veil before what he now beholds. But still more strongly does the power of the innate influence the returned traveller who seeks to reproduce his impressions of travel. This explains why it is that if a traveller in the tropics—especially if he be a poet—has been, for example, to India, he describes not the Indian landscape as it really is, but the European landscape which has been familiar to him from childhood, disguised, so to speak, in an Indian dress. The poet in particular does not give us an objective impression, but the expression of his own sensations. But even the ordinary descriptions of the traveller are often distorted by his innate ideas. Only by a strenuous and exhausting effort is one able to see into the alien Nature of the tropics and realize its essential character.

By comparing my visit to Ceylon (1910–11), which lasted for six months, with my sojourn in South America (1923–24), when I spent just a year on Brazilian soil, I learned that one does not really obtain a complete impression of a country until one is able to observe Nature through all the seasons of the year. But while travelling in two different tropical countries will prevent one from drawing general conclusions from observations which hold good of one country only, it also makes one realize that there is a definite tropical character which is common to all countries under the Equator, and which differs fundamentally from the character of more temperate latitudes. To determine this difference, and to explain it in a scientific manner, is the task I shall now set myself.

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The fundamental factor in the evolution of a type of vegetation is the *climate*. People usually think that the tropical climate is distinguished from the climate of Europe by temperatures of a height unknown to us. This is not the case. In Freiburg and Bayreuth, in July and August 1925, my thermometer stood 7·2° higher than on the hottest day in Pernambuco. Here is a table of maximum temperatures in the middle of the year:

Pernambuco	89°	Leipzig	91°
Colombo (Ceylon)	91°	Berlin	91·4°
Rio de Janeiro	97·7°	Timbuctoo	117°

BAHIA, FROM THE IMMIGRANT STEAMER *GELRIA*

VIEW FROM VICTORIA, ESPIRITO SANTO

Thus Rio de Janeiro is hotter than Pernambuco and Colombo, although the capital is on the southern border of the tropical zone, while Pernambuco and Colombo are only 8° respectively south and north of the Equator. And Berlin shows a higher temperature than either of these tropical cities.

A second table shows the mean temperatures of the hottest months:

Pernambuco	80·8°	Leipzig (July)	64·4°
Colombo	81·3°	Berlin	65·8°
Rio de Janeiro	79·9°	Timbuctoo	84·5°

But while in Leipzig and Berlin the temperature in the coldest months may fall to zero Fahr., in Pernambuco the mean temperature of the coldest month (July) is 75°, and the minimum temperature of the year is 64·9°. In Rio the mean temperature of the coldest month is 70·1°, whereas in eastern Germany the mean temperature is below the freezing-point, and in western Germany only three or four degrees above freezing-point. We see, then, that the essential difference does not consist in the higher temperature of the tropics, but in the fact that the tropics are distinguished by a *uniformly* high temperature. The variation in the course of the year averages less than 18°, whereas in Europe it averages 86°! Consequently a table of mean annual temperatures reveals the real nature of the difference:

Rio de Janeiro	74·8°
Pernambuco	78·2°
Berlin	48·3°

In the temperate zones we have a warm and a cold season in sharp contrast, whereas in the tropics it is summer all the year. Our plants have to reckon with a winter which brings their growth to a standstill or kills them completely. For the life-process needs warmth for its operations, and owing to the large amount of water contained in plants—and their stems, rich in sap, may contain as much as 96 per cent. of water—the whole body of the plant becomes rigid if the thermometer sinks below freezing-point.

Now what is the natural consequence of the fact that whereas our plants are actively living only for a few months in the year, the tropical plants are active all the year through? It is obvious that a tree which has hardly half the year at its disposal must work twice as hard as a tree whose life knows no interruptions. The organs of the plant which, like a chemical laboratory, with the help of the sunlight and the water rising from the roots, manufacture the materials needful for further growth, are, as we know, the leaves.

Our trees, therefore, need more leaves than the tropical trees. And we find that in general the foliage of our trees is thicker than that of the tropical trees, in which a mighty trunk is often surmounted by a surprisingly small crown, so that one can usually follow the ramifications of the boughs to the ends of the twigs. Very often the boughs bear, on the tips of their twigs, only a thin, domed disk of leaves (Plate 11).

Similarly, the blossoming season of our plants is necessarily short, while in the tropics not a month goes by but fresh plants open their flowers. A host of meadow-flowers delights us in spring; but in the tropics such a carpet of flowers will be sought in vain. In Europe the simultaneous appearance of the leaves of the trees, as of the flowers of the field, is a conspicuous characteristic. And this characteristic is naturally more effective than the distribution of flowers and foliage over the whole year, as in the tropics.

When in early summer a European enters such a little covert as we find, for example, on the Upper Rhine, and passing between the scented billows of the hawthorn, musical with the song of birds, pushes his way through thickets overgrown with honeysuckle and briony, above which oak and ash and other trees spread their leafy crowns, and at last comes to a clearing where orchids lift their purple spires from the grass and a pheasant rockets up with a gaggling cry, he tells himself that this is a scene of tropical luxuriance! He imagines, at the Equator, a still denser confusion of greener and lusher foliage, a still greater splendour of blossoms, a still more intoxicating fragrance. But he who visits the tropics with such hopes will inevitably be disappointed. For reasons already explained, the tropical trees are far less rich in foliage than ours, and their leaves are not so lush and green in appearance as those of a European wood. For the leaves of our trees let the sun shine through them, but such behaviour would be dangerous in the case of the tropical sun; in the tropics the leaves protect themselves by their dense, leathery texture, and by a glossy upper surface, which reflects the burning rays (Plate 15). And the third thing that we imagine in connection with a tropical forest—the fragrance—is more characteristic of our European woods. Of course, there are many trees in equatorial countries which bear scented blooms, and many orchids, but no scent of the tropics is as characteristic as the resinous fragrance of our pine- and fir-woods. There are no conifers in the tropics; nor do the equatorial forests know the intoxicating odour of the fallen leaves in the autumn woods.

Wallace was one of the first travellers to remark that in Europe Nature gives an impression of greater luxuriance than in the tropics, and other travellers have pointed out that even the greatest splendour of the tropics pales in comparison with that of an old quarry full of blossoming hawthorn and honeysuckle, or a woodland clearing gay with spring flowers. But while we do not wish to exaggerate the splendour of the tropical landscape, we must not fall into the contrary error. All in Nature is beautiful. It is beautiful because it is in harmony with the landscape from which it has evolved. Our woodlands would seem out of place at the Equator; I saw in Ceylon how all attempts to make an English park in the tropics, or a Mediterranean landscape of pines and cypresses in the hills, were invariably unsuccessful. To make such attempts is indeed to slight the powers of Creation, so far above all human effort and all attempted "improvements." In an alien landscape we can do nothing better than to make ourselves at home in it. Then its beauty should and will win our hearts.

And there is, of course, a tropical luxuriance; but it finds expression otherwise than in Europe; that is, in the production, not of a wealth of lush foliage, but of great masses of timber. In the tropics the plants are able to grow without intermission, whereas in Europe those which hope to survive the winter must fight a hard battle with frost and ice and snow. And in order to fight this battle our trees have had to adopt quite a number of protective devices. They cover their buds with scaly leaves, and wrap them in hair, or resin, or gum. The leaves are discarded in autumn, and then the tree more readily endures the gales of winter. But by far the greater number of our plants have never attempted to fight this battle; they have from the first declined to abide our winter. They surrender their stems and leaves, and hibernate in the warm earth, in the form of seeds or root-stocks. This means, of course, that every year they have to begin all over again; they are, therefore, unable to grow to any great height, and remain *herbaceous.*

In the tropics, as the botanist Haberlandt has remarked, arborescent or tree-like growth, and the reinforcement of the continually growing stem by the formation of wood, is entirely natural. Germany, for example, has only 36 native trees; Ceylon has some 1,500, and Brazil has many times this number. Families of plants which in Europe produce only herbaceous growths give rise to great trees in the tropics. For example, in Europe we know the Milkworts or Spurges (Euphorbiaceae) only as small plants, whose stalks, if broken, exude a white milky sap; but in Brazil we find among the Euphorbiaceae the tall rubber-trees, the Para caoutchouc tree or Seringueira, and the Ceará caoutchouc tree, or Maniçoba, whose milk, when it oozes from incisions in the bark, congeals in the form of rubber. The Andaassú tree of the coastal provinces, the kernel of whose large stone-fruit yields a powerful cathartic, is in high favour as a shade tree by reason of its size and its many branches. And the family of the Leguminosae, the second largest family of the flowering trees, containing no less than 12,000 species, whose representatives in Europe are peas, beans and vetches—if we except the acacia and laburnum and robinia, trees which were introduced from North America—this family, in Brazil, has produced the most magnificent trees, which give many of the forests their individual character. Among them are the Ingas or ironwood-trees, certain Jacarandás, the Jatobás, Arirabás, Angicos, etc.

Thus it is that the famous botanical garden of Rio de Janeiro is above all a park or arboretum, in which the trees play the principal part. And in the botanical garden of Peradeniya in Ceylon I even saw the employees grazing their cattle—a quite unimaginable sight in any European garden!

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Even from the outside the tropical forest reveals its wealth of species. Each one of its many kinds of tree has its individual mode of growth, and when we see the forest in the distance, over the low hills of the coastal landscape of north-eastern Brazil, its outline is serrated and irregular; here the trees lift themselves high against the sky, there they are lower; this tree is tall and slender, that outspreads a spherical crown, and above them all the great and spacious Leguminosae lift their spreading umbrella-shaped summits (Plates 12, 23, 30).

How uniform in comparison is the outline of a European wood! In the German forests, of course, the trees are mostly of the same age, and therefore of the same height, and only a few species are allowed to grow; often only two, and sometimes even only one. But in the last virgin mountain forest which is left to us, that of Kubany in the Böhmerwald, which has never been touched by the axe, I have noted that under natural conditions trees of the same species assume a great variety of forms. Here the spruce predominates, but while one tree, whose neighbours, broken with age, have fallen to the ground, is able to grow in freedom into a noble pyramidal form, another, closely hemmed in, shoots up towards the light, putting forth only the shortest boughs; while a third is deprived of light and air until it overtops the rest, and begins, when it is free to do so, to spread itself abroad like an umbrella-pine. Thus the outline of this forest is irregular, and this irregularity gives a certain wildness to the scene; the forest seems to be bursting with primeval energy, and it is as though those fir-trees which have shot up regardless of the pressure exerted on every side were proclaiming their victory.

The European forest, however, is naturally inclined to uniformity. In the foliaceous woods the densely-clad tree-tops are so inextricably intermingled that one cannot see where one tree leaves off and another begins. Our woods, seen from outside, give the impression of an unbroken green fleece whose gentle undulations are marked by faint shadows and transitions of tone. The whole is as though painted in water-colour. The tropical forest could be painted only in oils, and the gaze rests with content on the deep, vivid, saturated greens with their gleaming high-lights. The greens of the tropics are for the most part darker than our greens; even by the Mediterranean the golden oranges glow in a sombre foliage.

But the tender, uniform colouring of the outer surface of the forest is absent in the torrid zone. Here each tree-top stands out bodily and individually; each shows a different shade of green, and thus the picture is rich in colour and modelling. The face of the forest is netted and streaked by the light-coloured boughs and trunks, for just as human beings prefer to wear white in the tropics, so the trees prefer to cover themselves with bark of a light colour. And on account of the sparse foliage one can distinguish the scaffolding of the boughs quite a long way off; for these even break through the crown of the tree, curling out against the sky in the most singular fashion. On the hills of Ceylon, where the tree-tops were of all different colours, from red and yellow to green, the trees reminded one strikingly of cauliflowers, although this did not in the least detract from the beauty of the scene. In the mountains the air was so limpid that one seemed to distinguish every leaf, and under the blue sky the plastic solidity of the forest was indescribable. In Brazil also the details of the trees were distinguishable even at a distance; on attempting to paint a Brazilian landscape I found I could not wash in the colour with a soft brush; with a sable as fine as that of a miniature-painter I had to lay point beside sharply-defined point of colour. The tropics call for a special technique of painting, and to judge by the pictures of tropical landscape which I have seen hitherto, this does not appear to have been discovered as yet.

Stately umbrella-shaped trees lift themselves majestically above the Brazilian forest, and extend their spreading boughs in peaceful majesty far above their companions. Their feathery foliage is of such a deep green that they always reminded me of the pines of the Mediterranean: so much so that I was sometimes deceived into thinking them pines. These splendid "umbrella acacias," as one might call them, belong to the Leguminosae, although they are of quite a different species to our acacias. Since these trees, like their relatives, our sweet-peas and our acacias, bear beautiful and fragrant blossoms, they give a quite peculiar charm to the forest. In November the woods on Corcovado near Rio were full of lovely fragrance, and here or there, above the billows of forest that tumbled down the hillside, rose the golden-yellow domes of the acacias.

Another family of plants, the Bignoniaceae, is represented in the forests of Brazil by trees with magnificent flowers. From its feathery foliage, mimosa-leaved like the acacia, the Jacarandá puts forth panicles of violet trumpet-shaped blossoms. The bow-wood tree also, the Pau d'arco, a relative of the Jacarandá, whose elastic wood is used by the Indians for making their bows, has flowers of similar shape and colour. It was in the south of the State of Pernambuco that I first beheld the wonderful sight of bow-wood trees in blossom. I was wandering through a valley whose sloping sides were covered with meadows, running up to the wooded heights, in which cattle were grazing, and through which little streams came splashing downwards; a landscape whose fresh and endearing beauty reminded me of the Black Forest. But the dark green of the trees was very different from the greens of Europe, and above this dark green rose on every side domes of light violet-blue blossom. So tender was the colour that it seemed to float above the blossoming trees like a bluish mist. Other tree-tops there shone yellow, and others had just unfolded their young leaves, which gleamed like silver.

Once I came upon such a bow-wood tree standing alone in a green meadow. Through the blue mist all the boughs were visible, and perched on the boughs, like crests of great green fleshy leaves, Gravatás or Bromelias were growing. In form and colour both it was like an incomparable work of art.

On the slopes of the ranges to the north of Rio the forest blossoms in the Brazilian autumn (when it is spring in Europe). After leaving the hill-girt city the train crosses a swampy plain, the Baixada, and then comes to the foot of the range, the "Raiz da serra," from which one can travel by one line to Petropolis, by another to Therezopolis, and by a third to Novo Friburgo. Each line has first to climb to the top of the range, the "Alto da serra," for the three cities lie behind it.

These three journeys are all delightful: for one thing, because it grows cooler every minute, as the carriages—which are pushed up the slope singly—rise very quickly above the level of the plain. At the foot of the range the Borboletas bloom like lilies, and the scent of these lovely zingiberaceous[1] flowers invades the carriage. Before us the steep wall of the range rises to a height of 3,000 feet and more. Now, as we climb, sharp and jagged ridges appear, then a lofty cone, and projecting masses of rock; every moment some fresh formation appears, and the rocks and peaks increase in size as the carriage proceeds. And the slopes of all the hills are green with the overflowing forest.

This, of course, is not the virgin forest, but the *capoeira*, as the Brazilians call the growth which springs up after a forest is felled. It is already a magnificent woodland, and there are lofty trees in it, but anyone familiar with the country will recognize the *capoeira* instantly by the Imbaubas, to be seen on every hand, with their umbrella-shaped or chandelier-like crowns of large lobated leaves, which look as though dusted with chalk, since the hairs on the leaves reflect the sunlight. The Imbaubas are found only in young woodlands; under the tall trees of the forest they are stifled, but after a clearing has been made they spring up in such profusion that at first sight they remind one of an artificial plantation.

On the slopes of the range the woods seem strewn with the panicles of the azalea-like Lent-flower, Flor de quaresma, of every shade from violet to wine-red; the blossoms of a bush or tree which owes its name to the fact that its lovely flowers are in bloom during Lent. Their leaves are so decorative in design that they almost seem to be geometrical works of art; the ribs of the leaf are connected by equally-spaced lateral veins, and they are often covered with silky hairs, or even pricked out with red.

The journey to Therezopolis is the most beautiful of the three; here the forest is in better preservation; the trees grow taller and taller; beside the track are whole groups of tree-ferns with their huge and yet delicately intricate fronds; streams roar down among the rocks, breathing coolness into the carriage, and suddenly, looming menacingly above the waves of the forest, the gigantic rock known as the "Finger of God" rises into the sky. Shortly after this the summit of the range is reached.

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[1] Of the ginger family.

When one is able to obtain a distant view from such an "Alto da serra" a magnificent panorama unfolds itself. From the steep flanks of the range, above which rounded summits and jagged peaks rise on either hand, one looks out over the wide green plain, on which only a few houses are visible, to the pale blue of the bay with its islands. Beyond the bay rise the intricate serrations of the further mountain-range, with the Sugarloaf, Corcovada and the Tijuca peak, all blue against the heavens, like a silhouette with bold, rhythmic outlines.

On entering the virgin forest one must not, in the tropics, expect "the shadow of the primeval forest" such as is often described in fiction. The tropical forest is full of light, and observant travellers —Schomburgk in South America and Haberlandt in Java—have already drawn attention to the fact that the third characteristic of the tropical forest is its brightness. The Indian jungle, like the Brazilian forest, is full of light to the very ground (Plates 12 and 13). For as we have seen, the tropical trees have fewer leaves than ours, because they have all the year at their disposal for building their tissues, and are able to perform their task still more thoroughly by reason of the greater power and constancy of the sunlight. Moreover, the leaves of most of the tropical trees have a glossy upper surface, in order to mitigate the power of the sun, and thus the virgin forest is full of gleams and flashes of light. A photograph can hardly represent it with any fidelity, because the glittering leaves photograph as white and give the impression of snow (Plates 13 and 14). Lastly, the leaves of tropical trees prefer to turn their edges to the sun, rather than allow the light to fall on their whole surface, as otherwise they would be overheated. The European trees, on the other hand, prefer the horizontal position; and this is particularly noticeable in the case of the beech-tree. The boughs of this tree are perfectly horizontal, and the leaves are set horizontally on the twigs. The result is that the ground is shadowed by the emerald screens, leaf touching leaf and arresting the sunlight. In beech-woods only those plants grow which can thrive in the shade, and a solemn twilight prevails in the woodland cathedral. When the beech grows it stifles the growth of other trees. The Oldenburg forest, for example, will gradually transform itself into a beech forest, since the ancient oaks and ashes and hornbeams are gradually reaching the age-limit

THE ENTRANCE TO RIO BAY, FROM THE SUGARLOAF

THE ATLANTIC COAST TO THE NORTH OF RIO DE JANEIRO

and falling to the ground, while their seedlings are stifled by the invading beech-trees.

Owing to the leafy screens of the beech-trees, the beech wood appears to be traversed by horizontal bands of green, and in the spring, when the green bands are drawn far and near across the grey trunks and the russet carpet of fallen leaves, they give the wood a delicate and peculiar charm. Moreover, the sun shines through the screens of foliage and sheds a green, subdued light through the tree-tops. This tender flood of green sunlight gives our beech woods a mysterious character; they are like the woods in a fairy-tale. This impressed me more particularly after my return from Brazil.

Transparence in the one case and *reflection* in the other—as Haberlandt pointed out—constitute the great difference between the European and the tropical woods. In a European wood most of the light seems to fall through the screens of the green foliage, whereas in the tropics a thousand rays of sunlight drift down between the branches of the trees, and are reflected by the leaves in a dazzling shimmer. For the European there is something exhausting about this glittering forest; one feels as though the gaze rebounded from all these brilliant points of light, whereas it gratefully drinks in the tender, translucent greens of a European wood.

The uniform illumination of the tropical forest enables plants to spring up everywhere, and this gives the interior of the forest a richness and variety unknown to Europe. The charm of a northern forest is on the whole divided between the roof of leafage, the colonnades of the tree-trunks, and the weeds and flowers that more or less cover the ground. In the tropical forest the plants and flowers are found sometimes on the ground, sometimes on the branches of the trees, now far overhead, now almost within reach, here growing upwards, and there sprouting forth sideways; and the result is a picture full of enchanting variety, and a mass of minute detail which would mock the efforts of a modern painter with his few broad brush-strokes. But the lianas and arboreal plants which play so prominent a part in the structure of the tropical forest are plants of so peculiar a character that I must speak of them in a separate chapter.

In the virgin forest of Alto da Serra (Plate 13) near São Paulo, one of the loveliest jewels of Brazil, this peculiarity of the tropical forest is very apparent. The forest begins where the plateau, over 2,500 feet in height, ends in an almost perpendicular drop; and from its edge one obtains a magnificent view of the plain of Santos lying far below, its green floor traversed by many watercourses, while beyond it lies the blue ocean.

On the very threshold of the forest the imposing vivid red inflorescence of the Bishop's Heliconia rises out of a foliage not unlike that of the banana, but on a smaller scale. The delicate fan-like fronds of the Gleichenia cover the ground with a living carpet, and from this a Lycopodium rises like a fresh green fir-tree. Where the grass ends at the edge of the forest a sky-blue iris looks at us with friendly eyes, and a white Polygala glimmers in the distance (Plate 11).

Now we enter the forest, which spreads away over the mountains. On the ridges the trees are of middling stature, gnarled, and with heavy branches; in the valleys, which are sheltered from the wind, their trunks grow to a considerable height, and the jungle becomes a timber-forest; cool, plashing streams, roofed over with ferns, flow through these valleys, and tiny frogs call from under the fronds. In the distance a Tovaca pipes its rising series of chromatic notes; a small woodpecker, not unlike an Oriole, is clinging to yonder tree, and now we hear the resonant voice of the black Gurundi with its blood-red cap.

The trunks of the trees are green with moss, and often half-rotten; little round balls of the lichen-like "Greybeard" (Tillandria) perch upon them (Fig. 7) and long green branching cacti hang half-way up the trunks; on all sides there is a tangle of bamboos and lianas, many of the latter bedecked with flowers, while orchids and Bromelias often cover the boughs so closely as to clothe them like a fleece. They grow, too, on the trunks wherever the smallest chink or protuberance offers them a natural seat.

Here a stream leads down into a wooded valley, where trees with mighty trunks tower into the air. On the boughs, high and low, sit Bromelias (Plates 18, 27, 28). In some of these the rosette of leaves has a red centre; others are surrounded by great red trumpet-flowers, while some send up spires of red blossom, which often have the shape and colour of red corals. Since almost every tree is of a different species, the forest is decked with an endless variety of leaves of every shape and size. Like long cables the lianas hang from the tallest tree-tops, and their perpendicular lines are interrupted by the bright green lacework of the tree-ferns, while here and there a palmetto shoots upwards, tall and slender as a taper (Plate 13); overhead, shimmering in the sunlight, the gracefully-covered comb-like fronds sway in the breeze, and in the silence one seems to hear a music as of aeolian harps.

I sat on a fallen tree-trunk and gazed long at the interwoven intricacies of the tropical forest. Flooded with sunlight, it was not the same for a moment. The high-lights flashing from the leaves were constantly shifting; suddenly the edge of a bough would be plunged into shadow, and now, blazing in the sun, the red blossoms of a Bromelia would seem to come palpably nearer. Soon the slowly-moving shaft of sunlight set some other miracle ablaze; now higher, now lower, some fresh beauty attracted the eye; it was as though the forest, in all its recesses, were every second engendering something new. In the silence this life and movement was almost uncanny; one was made conscious of the great "Becoming" of Nature.

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What a contrast to this glittering life is offered by the virgin forest of our German mountains, as I saw it at Kubany in the Böhmerwald in August 1925 (Plate 14)! Spruces, intermingled with fir, beech, mountain-ash and elder give this woodland its individual character. Here the twilight of the virgin forest falls upon the boggy soil, covered with the great leaves of the plantain, amidst which, here and there, lie outstretched the green and mossy trunks of fallen giants. A more solemn picture than that offered by this forest cannot be imagined; it speaks of death rather than of life; the fallen trunks are eloquent of the transitory nature of earthly things; and where behind the reddish-yellow timber of a shattered trunk the spruces whisper and move in the shade, their needle-like foliage reminds one of rain or falling tears.

In the virgin forest of Kubany the prostrate trunks are the most individual and conspicuous feature of the scene; and the same may be said of the fallen oaks of the Oldenburg forest, which lie on the ground for decades without suffering any visible change. For the renewal of the forest they are of inestimable value; in the Kubany forest whole rows of young spruces grow upon them; they thrive better in this elevated position, and they are not covered with snow for weeks at a time. It has been reckoned that in the Russian forests 95 per cent. of the spruces grow in this manner.

In the tropical forest the struggle for the light does not seem to play the same part in the life of the wood as in Europe. It is, of course, darker in the forest than on the open plains; this the photographer soon realizes, for he can make only time exposures.

But the plants fight for the best position rather than for the light; the lianas fight for the best support, and the arboreal plants for those positions on the boughs which will receive the greatest rainfall. The tropical forest, like our own, is by no means the abode of peace.

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The Brazilian trees grow to a great height. Quite a number of species grow to a height of 150 feet and more. One such giant is the Sumaúma, and the Piptadeniae, to which group the Angico belongs, are equally lofty. The Australian Eucalyptus, of course, grows even taller; the tallest tree known is a Eucalyptus, and its height is 494 feet; only a few feet lower than the spire of Cologne Cathedral.

It is obvious that the trunks of such forest giants must be very strong, and so we find, among the thousands of Brazilian trees, many that yield the most admirable timber. We realize this in the houses, where the furniture is often beautiful in colour, and the parquet-flooring consists of woods of different shades. The wood of the Brazilian trees may be put to the greatest variety of uses. A Father of the Benedictine monastery at Olinda successfully replaced the metal reeds of a harmonium by wooden reeds, and the wood gave a softer tone than the metal.

Brazil has actually derived its name from a valuable wood. The name "Brazil-wood" was originally given to the wood of a tree of the East Indies. When the discoverers of Brazil found trees there also which yielded a dye-wood of a reddish-yellow colour they named the whole coast after this article of export, just as certain stretches of the African shore were called the Gold Coast, the Ivory Coast, the Slave Coast. There are several trees among the Leguminosae which yield Brazil-wood or Pernambuco-wood, but the most important of these was known of old to the natives, who called it Ibira-pitanza, by reason of its red wood. This fine tree has feathery foliage and thorns on the trunk and shoots. Brazil-wood is employed not only for constructive purposes, but also as a dye-stuff.

The Jacarandá is another tree which yields a wood of a fine dark colour, and various trees among the Leguminosae and Bignoniaceae bear this name. There are iron, violet, rose and white Jacarandás, and the wood of many species is marbled with brown or violet. Jacarandá-wood is known also as "palisander-wood," a corruption of *Pau santo*, "holy wood."

The iron-wood tree, Pau de ferro, is a tree with a smooth pink bark, which I saw in the Pernambuco forests, whose red wood is so hard and heavy that the tree can be felled only in the early morning; as the sun grows warmer the iron of the axe becomes softer than the wood, and will no longer cut it. Other Leguminosae are known as Angelim, Brauna, Cumbarú, Jatobá, Arariba, Campeche, Inga and Angico trees. The family of the Bignoniaceae includes the Ipés and the Bow-wood tree, which has blue or yellow flowers. Other related trees, the Imbuias, are utilized in São Paulo for the manufacture of expensive furniture.

The Sapucaja may be recognized at a distance by its whitish-grey bark, which displays a regular pattern. It yields not only an excellent wood, but also edible fruits, for this tree belongs to the Lecythidaceae, whose nuts, known to the trade as Pará-nuts, appear on our Christmas dinner-tables as Brazil-nuts. The three-cornered, hard-shelled nuts are the seeds of the fruit; they are contained in a large, almost spherical pot-like shell, as delicately packed together as though an experienced packer had been at the utmost pains to make the most of the available space. The Brazil-nut tree may grow to a height of 160 feet, and its nuts are an important article of export from the Amazon basin.

The Massarandubas are likewise very tall trees; the various species are distributed all over Brazil; some of them yield very valuable timber, and also pharmaceutical preparations and fruits, for they belong to the Sapotaceae; of this family the Sapoty is a favourite fruit-tree. I must not forget to mention the many species of laurel, whose wood is known as *canella* and *louro*, and the Brazilian Cedar, which is not, as a matter of fact, a conifer, but a huge tree with pinnated leaves; it would really be better to call it a Cedar-ash or Cedrella. The red, aromatically-scented wood is used for cigar-boxes, and is also employed to make termite-proof furniture. The greater part of the wood imported from America as mahogany is said to come from the Cedrella, while the genuine mahogany comes from Central America and the West Indies.

The list of the valuable Brazilian woods might be continued for several pages, but what I have here said of them will suffice to give some indication of the wealth of the virgin forest. The botanist A. Hoehne of São Paulo numbers forty-seven families of trees in his valuable *A Flora do Brazil*; each of which contains a whole series of species that furnish useful timber.

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The mighty trunks of the tropical forest trees need a firm anchorage, and according to their species they seek to obtain this anchorage either by sending a tap-root deep into the ground, or by increasing the area of the supporting surface by means of far-extended lateral supports. In the latter case the lateral roots spring from some distance up the trunk, and then, like gigantic combs, run in all directions over the ground (Plate 12). Such roots are thrown out by the Sumaúmas, the Cajás, or Cashews, or Balsam-plums, with their yellow, acrid, but pleasantly-flavoured fruit, and above all by many of the Leguminosae, whose great parasol crowns, when the wind seizes upon them, need a correspondingly wide anchorage down below. The stems of such trees merely rest on the surface of the ground, and in order to fell them one has only to chop off their roots. When overthrown the tree has a startling appearance, with its flat bundles of roots staring into the sky. These roots were once of great value to a people which had invented the axe, but not the saw. I was always attracted by the deep crevices between them, in which various animals, and especially snakes, were in the habit of taking refuge.

These roots support the lofty trunks like the piers and flying buttresses of our Gothic cathedrals. The branches of the parasol-trees, rising in flat curves, meet in a sharp point, and remind one of the ribs of a Gothic vault. Just as the essential part of a church is the framework of pillars and ribs and buttresses, so that a Gothic cathedral would stand even without its walls, so in the tropical forest the essential thing seems the structure; the more so as the absence of an excessively dense roof of foliage enables the eye to follow the rhythmic lines of the limbs and branches. The natural energy of the tropical forest, the "luxuriance of the tropics," expresses itself not by smothering the forest with masses of lush foliage, but by creating a powerful and monumental structure. The outlines are more vigorous than in a European wood; many trees put forth their boughs horizontally, and then turn them upwards at a sharp angle. In some trees the boughs coalesce with one another or with the stem, reinforcing the strength of the tree; in others the whole trunk is fluted as though a bundle of individual stems had coalesced to form a trunk (Plate 15), and here again we are reminded of a Gothic cathedral, for the pillars of the latter are often surrounded by semi-detached shafts. In India a single tree may constitute a whole temple of columns. The Banyan or Indian fig extends its branches horizontally, and from these aerial roots grow downwards until they reach the ground, which they penetrate, when, gradually increasing in girth, they themselves become stems, until the huge horizontal roof of leaves rests on a whole forest of stems, although the whole represents only one individual tree. In Ceylon I often entered such a grove, and it was always some time before I could convince myself that the whole represented a single tree. In Calcutta there is a Banyan-tree with 562 root-stems, and it is related that on one occasion an army of 5,000 soldiers encamped in the shadow of a fig-tree. In Buenos Aires fig-trees have been planted in the streets, and since the pavement made it impossible for the aerial roots to enter the ground, the trees, with their wide-spread boughs, are still standing unsupported, and the resulting roof of foliage, as perfectly flat underneath as though trimmed with shears, presents a most peculiar appearance.

In the Argentine I have often admired the monumental character of one of the native trees, the Ombú. The roots rise from the ground like great brown bladders, lifting the trunk into the air, and from the trunk the branches spring like a tracery, bending forwards and then backwards, and often interlacing to form the crown. In August the tree is leafless, when it looks more monumental than ever.

Many of the tropical trees shed their leaves before decking themselves with blossom. Such, for example, is the habit of the Silk-cotton trees. In Ceylon, where there are a hundred species of deciduous trees, I gazed with admiration at the Silk-cotton tree, which had just decked itself with its great glowing crimson flowers, while amidst the billows of rosy blossoms the Ceylon starling was singing its metallic and sonorous strophes—the tropical equivalent of the blackbird singing in the blossoming cherry-tree. In Brazil there is a species of Silk-cotton tree which when old has enormous board-like roots, so that at the level of the ground the tree may have a circumference of as much as a hundred feet, while in another species the trunk falls away at the top like a turnip, and the thick branches spring directly from the constricted neck. The heavy appearance of this tree is enhanced by the large green seed-capsules which hang from the leafless twigs, and which are lined inside with a silky cotton (Fig. 8).

Throughout the tropics the fruit often enhances the ornamental character of the tree. In the case of the Mango-tree the mangoes hang from their stalks as though suspended on strings, reminding one of the apples and oranges on a Christmas-tree (Plate 22). In the Jaboticaba, a myrtle-tree, even the trunk looks as though beaded with the blue-black fruits, about the size of a damson, that seem to be nailed on to the bark; the fruits of the Jaca, as large as a man's head, seem to grow directly from the trunk and boughs (Plate 22), and so do the violet fruits of the Cacao-tree, as large as a clenched fist. In one of the public gardens of São Paulo there was a spreading fig-tree under whose shade I found it pleasant to sit until one of the figs growing from the boughs fell on my clothes, which were stained with the oozing milk.

In all such trees, of course, the flowers too grow on the trunk, and the effect is often very beautiful. In Olinda it was always a pleasure, when I left the monastery garden for the street, to pass through an alley of Jambo-trees, which, with their crimson flowers, set like candles on the branches and glowing in the green foliage, looked as though they had been illuminated.

Even the leaves of the tropical trees contribute to the monumental effect of the whole. When I was in Ceylon I used to think, when I looked at the Palmyra palms which grew on the slopes of the sandhills, with their great fan-shaped leaves outstretched against the blue sky, that these trees were more like examples of the wood-carver's art than living plants. But although the huge leaves of the palms are not rivalled by those of other trees, yet there are many species with large and ornamental leaves: for example, the Breadfruit-tree (Plate 22), which comes from the Moluccas, but has been naturalized throughout Brazil. With its huge, deeply-incised leaves it is a magnificent sight. There is a climbing plant, the Monstera, which has deeply-incised leaves that are also perforated, presumably in order that the sunlight may fall on the lower leaves, which otherwise would be completely shaded by those above them. In Europe this handsome plant is grown indoors, and is known as the Philodendron.

But in the tropics even the entire oval leaves often attain enormous proportions. The great leaves of the Magnolias, which extend into the temperate zone, are familiar to Europeans; but in Sumatra there is a species of Magnolia whose leaves are more than forty inches in length and twelve inches in breadth! In order to increase the strength of such leaves the two halves are often bent upwards from the midrib, or the edges are fluted like corrugated iron. Such leaves are very thick, and of a leathery texture, and inevitably remind one of painted zinc.

Many leaves are stiffened by the silicification of their surface, which increases their durability, so that the tree can take its time over the production of new leaves; and the more enduring nature of the foliage of the tropical trees is one reason why tropical plants produce fewer leaves than those of the temperate zone. But there is, of course, yet another reason for the solid construction of tropical foliage; the leaves have to resist the tropical rains, when the water comes down as though poured out of buckets. In Java it has been noted that imported European plants are beaten into the ground by the rain, as though by a shower of hail.

Other trees, like the sacred Bo-tree of India, provide their leaves with a sort of pointed rain-spout, so that the water runs off them; or the leaf is divided into mere pinnules, which offer no resistance to the rain. The numerous family of the Leguminosae has adopted this plan, but the pinnate leaf is favoured by other groups also, as, for example, by the Mimosa-leaved Jacarandá. Many of these leaves are of considerable size, but are none the less so finely divided that they seem the work of an artist, or produce the effect of green lacework. The pinnate leaves have the power of turning to adjust themselves to the light; if the rays of the sun are too powerful they turn upwards; in gloomy weather, such as occurs before the rains, they sink again, and when the rains begin they at once assume the position in which they will offer least resistance.

The "Sensitive Plant," or true Mimosa, has this power of movement in unparalleled perfection. This shrub is a native of Brazil, but has been introduced into all tropical countries, and is the despair of all gardeners who are trying to make a good lawn. If one touches one of the pinnate leaves of the Sensitive Plant, first of all the pinnules fall, and then the leaf, and then suddenly the whole stalk folds downwards. Even the slight tremor caused by walking on the turf releases the reaction, which is propagated like a wave; the green leaves droop, and the ground looks as though covered with withered weeds; only the rosy balls of blossom and the spiky stems of the plant are still erect. It is, of course, possible that the plant is not merely seeking to protect itself from the rain by such behaviour, but that many herbivorous animals would draw back on seeing only the apparently withered foliage and the menacing thorns.

On the floor of the virgin forests of north-eastern Brazil the Bauhinias predominate, plants which belong to the Leguminosae. Many of these have beautiful flowers, as large as a lily, in colour a fine rose-pink; but, curiously enough, one of the five petals is quite different from the rest, being flecked with a rich, deep crimson.

The leaves are a light green, and sit on the rising stems like twin-pointed pennants (Fig. 5). In some species the leaf is split all the way down, in others only half-way down, and in some only the tip of the leaf is incised; and the tips are sometimes rounded, sometimes pointed and divergent. It is a pretty sight when one walks through the forest and sees these graceful pennons waving all over the ground; for even on the ground it is rare to see dense masses of foliage. Any wood in which the tops of the trees meet overhead suppresses the undergrowth unless this consists of plants which are adapted to living in the shade. Such, for example, are the jungle Bamboos, and the Nillu, a plant with a beautiful flower and a pleasant fragrance, which grows in the highlands of Ceylon. There the trees are less lofty and more sparsely clad with leaves than in the lowlands, and so they are surrounded by a sea of such undergrowth. And Fräulein E. Snethlage, who has spent years exploring the forests of the Amazon, states that in the timber forest it is possible to travel in all directions. When the forest is impenetrable it is so by reason of certain species of creeping and climbing plants, of which I shall speak in the next chapter.

The huge leaves of the Brazilian Arums are perhaps those which give the most vivid impression of being not leaves but works of art. In Europe only a small wild Arum, the Cuckoo-pint, is native, with a whitish spathe enclosing a club-shaped spadix, which subsequently bears red berries. In the Scherzeria Arum of Brazil, however, the spathe is a brilliant red, while the club-shaped spadix emerges from it like a twisted stalk of coral. Other species develop their powers of coloration in the leaves. The great leaves of the Caladiums, in particular, have the loveliest marblings and ornamental markings in green, white, red, and other colours, and these leaves hang perpendicularly from the stems, like the tapestries hung from a balcony to decorate the street. These masterpieces of Nature are like pieces of figured velvet.

In the tropical forest, then, we have all imaginable colours, set against the brown of the tree-trunks and the dark green of the leaves, and besides these colours there are everywhere the flashing reflections of the foliage. Bright green is the only colour lacking; when we do find it, as in the Cashew-tree and the Mangrove, we feel that it is a refreshing change, although the green of these leathery, glittering leaves is not like our Northern greens. Not even the young leaves, which in a European wood are the tenderest, the most transparent and succulent things that plant life can produce, have these qualities in the tropics. On the contrary, they have to protect themselves against the rays of the tropical sun even more effectually than the older and more resistant leaves, and so we see that they adopt the protective measures of the latter in an intensified form.

Treub, the botanist of the botanical gardens of Buitenzorg in Java, thought that in the tropics one ought not to say that "the trees are bursting into leaf"; that it would be more fitting to say that "the trees are pouring out their leaves." And it really does look like this when the young leaves of a number of tropical trees and shrubs are hanging in dense bunches from the tips of the twigs. They are then still soft, and can be curled round the finger. A singular spectacle is afforded, for example, by a great Mango-tree, whose long, lanceolate leaves stand out like divergent rays all over the tree, so that it seems to be clad in a mantle of green stars. From all parts of this green mantle twigs emerge from which the young leaves are hanging like brown rags; for even their colour serves to protect the young leaves from the sun. They do not need to produce their green chlorophyll immediately, as do our leaves, which are obliged to make the most of the short summer, and must begin their work of helping to build up the tree from the very first day of their unfolding.

In many trees the young leaves put on the loveliest colours. The young pink leaves of the Cashew-tree harmonize most delightfully with the bright, varnished green of the maturer foliage; but sometimes they display a vivid, burning red. In the highlands of Ceylon, at a height of 6,000 feet and more, the tree-tops of the virgin forest were ablaze with such glowing colours that I would not at first believe that I was looking, not at flowers, but at foliage. Every tree-top had reached a different stage in the development of its foliage, so that one was red, another orange, and others were yellow, brown, and green. In the clear air of the heights each tree-top was sharply distinguished from its neighbours, so that under the blue sky the mountains were covered with a variegated carpet of indescribably splendid colours.

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Many readers will have wondered why so little is said of palms in this description; they are, perhaps, accustomed to imagine the tropical forest as full of palm-trees, and I have often seen imaginary pictures of tropical forests which consisted entirely of these trees. This idea, however, is erroneous, for the palms are lovers of the sunlight, and prefer the grassy plains, the seashore, or the banks of rivers. The palms belong to the Monocotyledons: that is, to that order of plants with parallel-veined leaves to which the grasses and the lilies also belong; and like the latter, they grow from below upwards, and not simultaneously in all directions, while gradually increasing the diameter of the stem. It is said of the palms that they do not grow thicker, and as a matter of fact the stems are developed by the successive fall of the older leaves as the top of the trunk grows upwards. Either the leaves break off from the leaf-stalks, when the trunk is covered with a pattern of short stumps, or the spathes and leaf-stalks also detach themselves, when the stem shows ring-shaped or shield-shaped marks on an otherwise smooth surface, as in the case of the coconut-palm. The circumference of the trunk is, however, much the same when the tree is grown as when the crown is only a short distance from the ground. Many palm-trees, indeed, like the Royal palms, are thickened near the ground like an onion when they are young, as though they were storing up the building material for their subsequent growth (Plate 2). But in its journey upwards the great crown needs plenty of room, and in a forest full of trees and lianas it would be constantly impeded and entangled, and would in the end become atrophied and stunted. This has already been pointed out by the botanist Haberlandt.

Palms, therefore, are hardly to be found in the Indian forests; in the Brazilian forests they grow, as a rule, only in swampy and sparsely-wooded areas; there the Burity displays its handsome fan-shaped leaves (Plate 15), or the Pachiuba waves its great pinnate fronds above a trunk standing on tall stilts. In the interior of the virgin forest only palms of small stature with comparatively small crowns are found; for example, the forests of São Paulo are adorned by the Palmito, a slender, graceful palm (Plate 13), while certain of the Bactris palms are so small that they form almost an undergrowth. One species protects its inflorescence by a brown leaf, as by a roof. But the palms are not characteristic denizens of the virgin forest, which owes its character to the foliage trees, as I have already explained.

In the virgin forest the Tree-ferns (Plate 16) have more handsome and more wide-spreading crowns than the palms. With their horizontal unbrella-like screens of foliage they form a pleasant contrast to the vertical lines of the tree-trunks and lianas. In Europe we can admire this effect in respect of the delicate fronds of the bracken, but the tree-fern is far more impressive. Growing to a height of twelve or fifteen feet, with a rough, furry stem supported on short aerial roots, it spreads out a great umbrella-screen of green lace-like fronds As in the hill forests of Ceylon, so in the virgin forest of Brazil, I was always struck with admiration before the tree-ferns. When one stands beside a purling brook, in the forest of São Paulo, or Nova Friburgo, or Therezopolis, it looks as though some lady giant had left her parasol there while taking her morning bath, and had forgotten it on her departure. In the woods of Tijuca, above Rio de Janeiro, they grew in the moist ground beside the road, and the bright green of their fronds brightened the dark woodland landscape. Two species were frequent there; one with fronds like those of a European fern, while the other had denser foliage, and fronds which looked as though they had been built up of willow-leaves.

In the neighbourhood of São Paulo there is an estate on which the tree-ferns form the undergrowth in a wood of Araucarias. Like a green, perforated veil the great fronds lie waving at the foot of the tall trees. While there are no conifers in the tropical regions, the "Pinheiros" or Araucarias are characteristic of the landscape of sub-tropical southern Brazil (Plate 17), and on the hills they grow even above São Paulo, which is on the Tropic of Capricorn. I first saw these fine trees at Petropolis, at an altitude of 2,500 feet. When on my first morning in Petropolis I woke and opened the window the aromatic scent of resin and pine-needles entered the room, while outside, in the garden, the sun was lighting up the rounded summits of the Araucarias and reddening their trunks. The Araucarias are not unlike our pines, but they are more regular in build, and the twigs of the crown bear thick bunches of needles only at their extremities, so that the tree reminds one of a candelabrum, and has a rather solemn appearance. Even in the forest the Araucarias preserve their peculiar character. Since the crowns of the trees are not all of the same height, each is plainly distinguished from the rest, and if one looks down from a height on the wood climbing the opposite slope, the crowns of the trees are seen as flat discs of green, and the sea of tree-tops is like a great chessboard, glowing in the evening sunlight with every imaginable tone of green. A mist rises from the floor of the valley; it grows cooler; and we go homeward through the dark, odorous wood, the friendly lights of the house twinkling through the black tree-trunks.

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It is delightful to wander through the forest in north-eastern Brazil.

It is still dark, but the household is waking, and voices are heard in the adjacent rooms; for in the country houses of Pernambuco the walls of the rooms are not carried up to the roof, but end at what would be the level of a great loft if there were a ceiling, so that at night the bats fly over all the rooms in turn. We get up quickly; already the splashing of water is heard in the different rooms; and presently we go out on the verandah, where the little frogs are croaking from the thatched roof. The stars are still twinkling overhead; the forest is black against the sky; the valleys are swathed in a white mist.

We step out smartly; the east is slowly growing lighter; there is a ruddy flush on the horizon, and near and far are no longer confused. Horses laden with wood come towards us; the track goes up hill and down over the felled woodland. Now the sun rises above the horizon; its first rays strike the forest, and the tree-trunks are picked out in red. The fresh voices of birds ring from the bushes at the edge of the forest, and even within the forest there is life. Silk-monkeys swing themselves along the boughs, and in a clearing some little green parrots are performing gymnastic feats, and loudly calling to one another. The birds are singing on every side.

By half-past eight, however, silence has fallen on the forest. The misty atmosphere of morning gives way to the clarity of sunshine. Everywhere the sunbeams are drifting into the forest, and the green leaves glow and glitter in response. Now the insects are waking to life. With outspread wings, of which only the tips appear to vibrate, while the narrow surfaces uninterruptedly display their black, red and yellow or black and yellow pattern, the Heliconid butterflies float slowly through the air; the splendid blue Morphidae too pass gleaming through the glades, and up the tree-trunks climbs a beetle, Euchroma gigantea, the bright green of his wing-covers flushed with a red metallic bloom, while the dark spots on the scutum look like black eyes. Late in the afternoon the forest is less silent. A shrill *Tüi*, *tüi*, *tüi*, rings out; the Forest Leguan, a lizard, uplifts his voice. With a loud whir, a startled cicada makes a dash for the next tree, the heavy body tearing through the air with its long glassy wings; a great gorgeously coloured toucan flies off, a squirrel whisks up a tree, and perhaps we may catch sight of the yellow arm of a sloth slowly jerking itself forwards.

As the sun sinks the forest grows noisier. A hedge-sparrow is scolding in the bush before settling down to sleep, and the little cinnamon-coloured Curutia is uttering shrill cries. Once more a flock of parrots flies with excited shrieks above the tree-tops. And now the deafening, whirring song of the cicadas begins. The whole forest seems to vibrate with it until one's very flesh feels the vibrations; and the wanderer's heart goes forth to all this teeming life.

It is quieter in the woods which clothe the hills up which the great city of Rio de Janeiro is pushing its cohorts of houses. I climbed the highest of these mountains, the Pico da Tijuca, and after a good deal of trouble made my way back to the highway, which follows a bold, curving line across the ridges and lateral valleys, and gradually descends towards the city: now affording one a view of the solitudes of the mountains (Plate 24), and now delighting one's eyes with a glimpse, beyond the sea of tree-tops waving almost directly below, of the wide ocean.

While the wanderer breathes with content the cool, scented air of night as he strides down the road, he hears on every side, from the scrub at the edge of the forest, a cry of "Chick, chick!" There is something sweet and peaceful in this quiet, silvery accent, which accompanies us until we come to the end of the woods, and the city, a sea of light, receives us. I have never been able to find the creature which utters this sound, though I have searched for it long and thoroughly; it may be a little frog, or it may be an insect.

When on the day after my arrival in Pernambuco I took the electric tram to the edge of the woods, reaching them as the darkness was falling, the unmistakable sense of the tropics, with which I had become familiar in Ceylon, at once took possession of me. A heavy odour of decay rose from the rain-wet ground, and the silence of the tropical night settled heavily and deliciously on my heart, like a recovered mistress. For it is a remarkable fact that although in the tropics the night is often much noisier than in Europe, since the frogs and the cicadas fill it with their cries, it nevertheless impresses one as being peculiarly and impressively silent. The reason is, perhaps, that we are not accustomed to such a combination of darkness, and vegetable odours, and summer heat. With us Nature is not wrapped in darkness until a late hour of the night, so that we are doubly impressed by the onset of night at six o'clock in the evening. And as in the darkness we often imagine that we can hear something breathing, so, in the silence of the night of the tropical forest, when all the little superficial sounds are stilled, we seem to feel Mother Earth herself rising and falling as she deeply and silently draws her breath.

V

THE LIANAS

We now come to a component of the tropical forest which is as essential a part of its expression as the wrinkles in the forehead of an old man, and the lines about his mouth and chin.

The plant-world of the tropics does not live only by growing upwards toward the light and spreading out its broad crowns of foliage; it lives also by creeping and climbing. And it is precisely this characteristic which is most unfamiliar to the European, and which produces the most lasting impression.

Moreover, the tropical creepers and climbers contribute more than anything else to the magic of the equatorial forest, and they deserve the pleasant-sounding name which the French brought with them from the West Indies—lianas. In Brazil, however, the lianas are known as *cipós* or *trepadeiras*.

These serpentine, twining growths are true children of the tropics. Kerner von Marilaun estimates the ratio of the climbing plants of Europe to those of the tropics to be 200 : 2,000; and Grisebach reckons that the woody plants of the West Indies constitute 33 per cent. of all the higher forms of vegetation, and the woody lianas 8 per cent., while in Europe the proportion of *all* species of creeping and climbing plants is only 1·8 per cent. Within the tropics, America has nearly twice as many lianas as Asia. Brazil, in this respect, holds the palm.

And if we take Europe alone of the lands of the temperate zones, the number of the climbing plants is still further reduced. Of climbers with woody stems we have really only three of any importance: the ivy, the clematis, and the honeysuckle. And the two latter, at all events, do not favour the depths of the forest, but rather the fringes of the woods, or the bare rocks and thickets of a quarry, when they grow in such interwoven intricacy—assisted by the wild hop and, above all, the thorny bramble—that the whole becomes quite as impenetrable as a tropical forest strung with lianas.

Since Europe has but few species of trees in comparison with the tropics, it is only natural that the woody climbers should be fewer in number. But why are our woods not richer in the herbaceous climbers, such as the peas, beans, vetches and hops?

VIEW FROM THE SUGARLOAF: LOOKING SOUTHWARDS OVER RIO

THE SUGARLOAF

We must look for the reason in the more brilliant illumination of the tropical forest, the greater number of points of support offered to the climbers, and the much greater humidity of the atmosphere. In our pine- or beech-woods the climbing plants—as Haberlandt has remarked—do not obtain more light by climbing higher, and if they grow as high as the top of a tree they pass, first of all, into complete shadow. In the better lighted tropical woodland, which is more uniform in structure at all levels, the lianas can find sunlight at any height. And this more uniform structure provides the liana with rungs by which it can climb, step by step, higher and higher. I have already remarked that the branches of tropical trees bend upward more sharply than those of our Northern trees, so that they offer all sorts of angles as points of support. Moreover, the sparser foliage of the tropics is more easily penetrated.

Again, the importance of more frequent rainfall in the development of the lianas must not be underestimated; it has, as a matter of fact, long been recognized. Observation shows that the woods of the drier tropical countries are poorer in lianas.

As a matter of fact, the problem of conveying the moisture which is taken from the soil through the long, thin stems is not an easy one to solve. Rattan lianas have actually been measured which were 780 feet in length, with an almost uniform thickness of an inch and a quarter to an inch and two-thirds! And when these plants unfold their leaves in the brilliant sunlight far overhead, the moisture evaporates all the quicker. For plants, of course, transpire, as everyone knows who has kept them indoors in winter in order to restore the humidity of air dried by artificial heating. The moisture lost by the leaves has to be replaced, and quickly, or the leaves and shoots would wither.

In order to convey the stream of water from the roots to the stem, branches and leaves, the body of the plant develops vascular conduits. These, of course, are of microscopic diameter, and if we tear the body of the plant asunder we can distinguish them only as fibrous strings, as they are provided with supporting fibres, and combine with them to form fibro-vascular bundles; in the leaves these appear as ribs, and divide to form the familiar vascular network.

If we now cut through the stem of a liana—one of the Brazilian "orchid" lianas—we can perceive with the naked eye the sieve-like perforations of the resected surface visible as tiny dots (Fig. 3), for in the lianas the vascular channels are unusually large, in order that the water may more readily flow through the long stems; they are sometimes more than a fiftieth of an inch in diameter. The upward "root-pressure" of the water is therefore particularly high in the lianas. Even in Europe, if we cut through a growing vine-stock in the spring, it begins to "bleed"—that is, the rising sap oozes out of it. Certain tropical lianas yield so much water when severed that they are known as the Phytocrene or "vegetable spring" lianas, and the traveller through the virgin forest can fill his glass with a refreshing drink from the severed stem of one of these creepers. He must, however, as Herzog observes, sever the liana a second time above the point of the first resection, as otherwise the sap will not escape. A severed piece of liana forty inches in length will yield a glassful of perfectly clear, cool water, with a pleasant and slightly acid flavour.

There are also lianas which contrive a shorter path for the water drawn up from the soil. When the Monstera or "Banana do brejo," which has already been mentioned, winds itself along a horizontal bough, it sends down roots, which grow longer and longer, and turn back directly they reach the ground. From this point rootlets grow down into the soil from the straight, smooth root, anchoring the latter, and as they draw it a little way into the earth they tighten the cable, so to speak, so that the water which rises from them flows upwards all the more readily. Under each new leaf two such roots are produced; it seems that the great lobate, perforated leaves demand an individual water-supply. In addition to these roots, the Monstera develops others which do not reach the ground, but have such a porous and absorbent epidermis that they are able directly to absorb the rain-water that falls on them, or the moisture in the atmosphere. This remarkable plant has thus four kinds of roots, for it has also roots like those of our ivy, which emerge from the stem at intervals, and embrace the trunks and boughs along which the creeper makes its way. The whole plant, with its huge leaves and hanging cables, offers a most singular and fascinating spectacle.

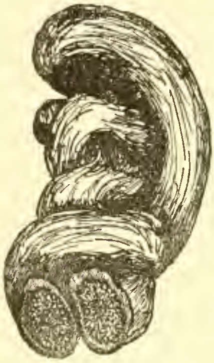
Fig. 3.—A section of a liana stem, in which the vascular channels are visible as holes in the cut surfaces. (After Kerner Hansen)

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Amazing indeed is the creative power which has produced lianas from so many different families of plants! Often one feels as though here a superabundant imagination had been put to the test—had been given the task of creating climbing plants which should yet be members of families which to all appearances were as ill adapted as possible to the production of climbers. Lianas had to be provided, first and foremost, with organs which would enable them to twine and cling, and these had to be developed from organs already existing; and since the organs selected by the various types of plant differed very greatly, those were adapted which were most suitable for the purposes of the liana. It is for this reason we find that some lianas anchor themselves to the trees by their leaves, others by their roots, and yet others by their stems. If we pass the lianas in review, we soon seem to have exhausted every possibility—and then we are suddenly surprised by some fresh solution of the problem.

Goethe was one of the first writers to treat of the metamorphoses of the organs of plants for the performance of new functions. Since his day a whole science has come into existence, which seeks to explain (for example) how a green leaf, under the influence of external and internal conditions, may become something quite different: a thorn, a tendril, a pitcher to catch insects, a coloured petal.

Who could imagine a fern as a liana? And yet there are climbing ferns; but what queer-looking things they are! In the forest of Alto da Serra I examined these curious plants with amazement. The whole frond—so broad and beautifully formed in ordinary ferns—has been reduced to the stele and the midrib, and a few small lateral pinnules which spring from the midrib at some distance from one another. But these comparatively frail and elastic filaments grow unchecked—I measured some which were over thirty feet in length—and twine themselves round the trunks of other trees. Not far from the climbing ferns I found the climbing bamboo, which the Brazilians know as Tacuaré. At intervals of about a foot the long, twining stems bore little spherical bunches of leaves. This symmetry was very pleasing, particularly when the liana was suspended from tree to tree. Still more attractive was the climbing grass, which wound itself round the trees, the bright green grass-blades hanging down all over the twining stems. But in forcing one's way through the forest one had to beware of the sharp cutting edges of these blades.

The palms too include climbing species. My acquaintance with these dates from my very first excursion into the forests of Ceylon. Suddenly my hat was snatched from my head, as though by a spectral hand. There was nothing to be seen, and I stood still in astonishment. At last I saw above me, hanging from a bough, a long, thin switch, which was still gently swaying to and fro. When I pulled at it I discovered that it was set at regular intervals with circlets of short recurved hooks, as hard as steel, like the claws of a tiny beast of prey, and I discovered that the switch itself was the elongated midrib of a finely pinnated palm-leaf (Plate 14).

It was the Rattan Palm which had made me aware of its presence in such a surprising fashion. With its slender, elastic stem it climbs high among the trees, and its pinnate leaves, which end in switches from three to six feet in length, hang downwards from all its parts. On a breezy day these switches, waving up and down in the wind, are blown against some neighbouring tree-trunk, where they immediately sink their hooks into the bark, and hold fast. The upper leaves in particular anchor themselves thus, and slowly the stem creeps after them. At last the summit of the tree is reached; and now the leaves wave their lashes in the open air; they can climb no further. In the meantime, however, the stem loses its lower leaves, and therewith its points of support; it begins to sag, and forms loop after loop, until the upper leaves are drawn back into the region of the branches, and enabled once more to throw out their grappling-irons. This happens again and again, and so finally, in the case of this and other lianas, we find a great serpentine tangle of stem at the foot of the supporting-tree, as it goes on adding convolution to convolution (Plate 19).

In Brazil there is another climbing palm, the Jacytára. I found it in Pernambuco, and was quite intimidated by its armament, which has earned it the name of "the terrible." Woe to the fugitive who attempts to move quickly through the undergrowth in which the climbing palm has cast its harpoons! He will leave behind him tatters of clothing, skin, and flesh, if he does not indeed collapse altogether in this fearful embrace. The long leaf (Fig. 4, A) of this palm has pinnate leaves at the base, though even these have thorns on their underside, as has the midrib from which they grow. The nearer we approach the tip of the leaf, the more formidable are the thorns, and at the same time they are transformed into reverted hooks. Further on even the pinnules are metamorphosed into hooks, and become as hard as horn. At the tip of the switch we can see plainly that these recurved hooks are really pinnules, and they even retain their green coloration.

The botanist Schenck, who has exhaustively studied and described the lianas, describes the climbing palms as "sprawling climbers." He means by this that the lianas with sprawling leaves or branches pile themselves up on their supports, so that their spines and hooks gain all the better purchase. Even our brambles are able to climb in this fashion. In Brazil many plants do so, as, for example, some of the Leguminosae (Machaerium), the beautiful Bougainvillea, which in Brazil is called "Sempre lustrosa" or "Primavera," and others.

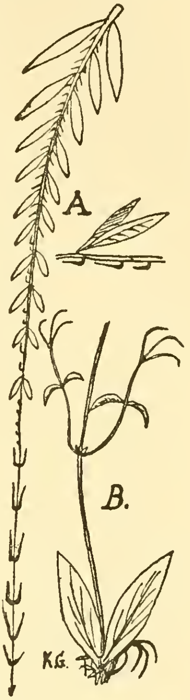

Fig. 4.—A, Leaf of the climbing palm, Jacytára (*reduced*). Beside it a fragment of stalk showing the spines and reverted hooks on the under side of the leaf. B, Young shoot of the "Cat's-claw" creeper with grappling-hooks (*natural size*)

Of the lianas which put forth roots from their stems, in order to clamp themselves to the supporting stem, the Monstera has already been mentioned. That there should be such "root-climbers" should not surprise us; we have already seen that the Indian fig sends down roots from its boughs, and if a branch of a willow-tree or a rose-bush is pegged down to the ground it will send out roots. In America the Bignoniaceae, of which the beautiful flowering Bow-wood tree and the Jacarandá are members, have produced some magnificent lianas. One of these, which is found in North America, and has even been introduced into the central and southern parts of Germany, is the climbing Trumpet-flower. This blossoming creeper, with its large, blazing red, funnel-shaped, bell-mouthed flowers, clings to bare walls with "suckers" like those of our ivy, which grow from the axils of the leaves and shoots.

The "Cat's-claw" creeper, so widely distributed in Brazil (Fig. 4, B), has developed still further on these lines. This climber is such a singular plant that one might almost suspect it of conscious animal activity. For example, we may find that such a liana has smothered a tree with its luxuriant growth; it is held fast by numbers of roots which have grown out of its slender stems. But now comes a time when all the available space is occupied, and the liana, if it is to continue its urgent growth, must seek a fresh support. A delicate green shoot appears, grows longer and longer, and sways to and fro in the breeze. But what do we find growing out of it? Clutching the air like the claws of a cat, or, better still, the talons of a hawk, the gripping organs grow out of it in all directions. They consist of metamorphosed leaves, while the true leaves are retarded in their development. Longer and longer grow the shoots, until the wind catches them and sways them to and fro. If no other stem is as yet within reach, the claws retract themselves and the leaves proceed to grow. But the urge is not appeased; once more fresh claws appear at the tip of the creeper, and the plant swings to and fro through an ever-widening arc. At last the wind blows the hanging shoot against another tree-trunk; immediately the claws enter into the bark, roots grow out of them, and the liana wanders over its new arboreal support, drawing after it, from the old one, a long festoon.

The twining lianas are those in which the stem itself embraces the supporting tree, winding round it like a snake as it reaches upwards. The virgin forest is full of such lianas, and it is these plants which give it such a strange and unfamiliar appearance. Many lianas begin by climbing up quite a slender sapling, or a reed, or even a grass-stem, from which they reach the trunk of a tree. Here they obtain the needed support, and the stem can now grow thicker and thicker; but it retains its twists and turns, under which the fragile supporting plant completely disappears. In the end the convolutions press against one another, and a twisted cable results, as thick as a man's arm (Fig. 3, Plates 15 and 24). These are known as "bush cables." They enhance the impression of a stealthy mechanism, of the latent energy of the forest.

The vegetable life of the forest would seem still more uncanny if our eyes could follow the gradual movements of the plants. For the shoots of the lianas do not grow upwards only, but in a slanting direction, and even horizontally outwards, and as they grow their tips revolve until they have described a complete circle. This circling movement of the tip of the shoot has been likened to that of the hand of a clock. If one lays a sheet of paper under the shoot one can follow the movement of the tip by watching the shadow. On an average, the shoot takes one to two hours to complete the circle.

The newer technical methods reveal this movement still more vividly. Photographs of a climbing plant are taken on a film with short intervals between the exposures. If the positive of the film is now run through a projector, the happenings of hours are reduced to minutes, and the movements of the plant are plainly visible. The shoots appear to move like the arms of an octopus seeking its prey. Now one strikes against a tree-stem, and forthwith it throws a lasso round it, while the rest of the shoot curls up like a corkscrew. The spectacle is most fascinating; the boundary between animal and vegetable life seems abolished.

But what an impressive spectacle would be afforded if a photographer were to make such chain-exposures in a tropical forest and then, by projecting the film, speed up the rate of growth! Since in many of the tropical plants the diameter of the circles described by the tips of the shoots may be as much as six feet, one would see long tentacles emerging here and there from the undergrowth, groping about in uncanny silence until they found their victim, and seizing it in their enduring embrace.

The most highly-organized lianas are those which do not enlace the tree-trunks with their shoots, but have developed special tendrils, which circle round in search of a support. These delicate, slender and elastic structures are so irritable that everything touched by them is at once embraced and held fast (Fig. 5). After a time that part of the tendril which lies between the tree and the liana contracts into a corkscrew form, drawing the plant after it, so that the latter is suspended as by a spiral spring.

Since the tendril is a specialized organ, serving an exclusive purpose, it is not surprising that it should do its work more rapidly than the shoots of the twining lianas. Many tendrils rotate through a complete circle in as brief a period as 25 minutes, and the tip of the tendril begins to curve within twenty seconds of touching a bough, so that in four minutes the first complete noose is thrown round the support. There are other plants, of course, whose tendrils are more deliberate. But the enlacement of the supporting tree-trunk or bough is effected more rapidly and completely by such plants as are equipped with tendrils. They pass easily from bough to bough, and form a regular overgrowth on the tree-tops; their shoots hang down into the trees, and seize upon fresh points of support, until at last a whole group of trees may seem to be swathed in a green foam, or ceilings and arbours of foliage spring into being. It is on the edge of the forest that such a spectacle is most frequent.

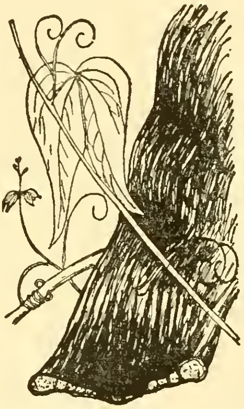

Fig. 5.—Section of stem of a Bauhinia, with leaf and tendril. (After Kerner Hansen)

Tendrils may be evolved from any part of the plant; the mid-rib, the leaf-stalks, the bracts, or what not. Many tendrils become climbing-irons; others coil themselves, even before they seize their support, into an elastic spiral, like a clock-spring; others develop spatulate "suckers," which enable the creepers to scale bare walls. Many tendrils grow considerably thicker once they have slung themselves round a supporting bough, and are consequently more difficult to dislodge.

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The stems of the lianas have also undergone extensive modifications in adaptation to their mode of life. When the wind blows the boughs which support them apart they must be able to resist a violent pull, and when they hang from the boughs overhead, or are slung from tree to tree in long festoons, they must be able to bear their own weight. One may seat oneself in such a rustic trapeze and swing to and fro. In order that the lianas may be able to give to a pull, they are often spirally coiled at the points of their attachments to the boughs, so that they can be drawn out like springs, contracting when the pull is diminished.

The stem of the liana is of a peculiar structure. It is frequently twisted like a cable; sometimes it is flat like a ribbon, as in some of the Brazilian Bauhinias (Fig. 5). These ribbon-like stems apply themselves closely to the supporting tree, but at the same time they twist themselves spirally or contract into undulations, giving rise to the remarkable formations known as "monkey-ladders." These modifications are possible because the lianas have not, like trees, a homogeneous woody structure enclosed by a circular sheath of bast and bark, the stem being built up of several woody structures, which are capable of shifting their respective positions. The structure of the liana is thus not unlike that of a cable.

The growth of the liana is not foreordained, like that of a tree, which grows permanently in one position, building itself up in its own characteristic fashion; for the tree supporting the liana grows upwards, and the creeper has to follow; the older it grows the heavier it becomes, until at last the massive stem can no longer support itself, and the older climbing-organs no longer fulfil their function, and one day the stem slips and slides downwards. Part of it may perhaps remain hanging from a crotch of the supporting tree; the rest collapses on to the ground. Since this process is repeated again and again, the elastic stem is eventually coiled into a serpentine tangle. When one sees the stem of a liana swaying above the ground, suspended by long cables from the topmost branches, one wonders how these living cables could possibly have reached the position they occupy. As a matter of fact, they have fallen into this position; the stem fell away from the tree, and the cables had to lengthen themselves in order to follow it.

One of the greater lianas is the Giant Bean or Entada scandens, which is distributed throughout the tropics. Its pods, almost as broad as a man's hand and more than a yard in length, are woody in texture, and hairy; the glossy brown beans are driven ashore by the ocean currents as far afield as Greenland and Europe. With its forked leaf-tip tendrils this giant liana climbs the tallest trees of the forest, and it is interesting to follow the windings of the massive stem with the eye as it rises from the ground, climbs a tree, on the further side of which it descends in spiral convolutions, slanting through the air to the crotch of another tree, and covering in all perhaps a horizontal length of a hundred yards.

The Brazilians use the thin, elastic stems of their Cipós as riding-switches, having first burned off their bark. It is the lianas which make the use of the bush-knife or cutlass necessary when travelling through the forest. With this heavy sickle-shaped blade one strikes right and left at the cables crossing one's path; none the less, one's progress is slow, as the ground is covered with snares and nooses for the unwary foot, and the naturalist who catches sight of a rare butterfly and hastens after it, full of enthusiasm, will suddenly find himself on the ground, unpleasantly conscious of the thorns, nettles and ants which abound there, while the butterfly flits away.

Since the lianas commonly blossom overhead, above the tree-tops, one sees hardly anything of their splendid blooms from the interior of the forest.

But if one comes upon a grassy hill, and looks down upon the forest outspread below, one may often see, in Humboldt's words, "a forest above the forest." I shall never forget the growth of Harpalyce above the forest of Pernambuco. It undulated over the tree-tops like a field of violet-blue ears of corn. The blossom is like that of the sweet pea, and the leaves are trifoliate, like clover.

The colouring of the Pernambuco landscape in September was magnificent. The season was like our European spring; the birds were singing and the frogs were uplifting their voices. A rich fragrance, as of cedar oil, floated on the air; it came from the Fleabane (Ruellia). It was a world of glowing violet and yellow.

If I approached the edge of the forest, the lower part of the green wall was flooded over with the violet trumpet-flowers of Ipomaea floribunda, and above these were scattered the orange-yellow, sprawling blooms of the Cassia. Here and there the yellow star of a Heteropteris peeped from the bushes; in this flower five prettily serrated petals stand upon little stalks which touch in the centre. There were blossoming peas here too, rose and violet; in one species (Fasceolus) the long narrow pod, strangely enough, grows out of the flower while the latter is still blooming.

It was always a joy to me to find the Passion-flower in the forest or upon its fringes; a green sea of foliage enveloped the supporting trees, and the great blue stars of the flowers looked down with their grave and lovely gaze (Fig. 13). Ten petals form the star, five of which are really coloured sepals. Above this star lies a second, consisting of fine, slightly crinkled threads, mottled with a glorious blue. They have been likened to the crown of thorns, and the stamens, rising from a centre which is adorned with circles of brilliant colour, have the form of nails, while the ovaries, with their three pistils, have been compared to a scourge. Passion-flowers with large red blossoms also are found in Pernambuco; in these the stamens are violet, flecked with white, and other kinds have whole racemes of blossom. The combination of lovely colour, delicate mottling, and decorative form is bewitching in all of them. Their mode of propagation befits their poetical beauty; for their large flowers are fertilized by the flying jewels of America, the humming-birds; the coronet of filaments apparently traps the insects on which these tiny birds feed. I shall say something of the fruit of the Passion-flower in the tenth chapter.

In São Paulo too I saw flowering lianas. In the forests of Alto da Serra the red flowers of a climbing Begonia shone as though self-luminous. Delightful too were the snow-white, woolly flowers of a Hylaea, which grew sometimes on the ground and sometimes climbed the trees; they reminded me of edelweiss, but were much larger. In August—so a São Paulo botanist, S. Decker, informed me—showers of orange blooms fall from the branches of the trees upon the surface of the rivers; they are the flowers of the climbing Pyrostegia. I myself saw waves of the turquoise-blue flowers of Thunbergia and the red Bougainvillea surging over walls and garden doors, and the scarlet racemes of the "Cipo tapé." These flowers, in shape like a sweet-pea, are incomparably luminous. One stands as though dazzled before the bushes which they adorn. And in the droop of the red racemes there is something lavish and generous which still further enhances the charm of these children of Nature.

The lianas have been likened to garlands, but it is only on the tree-tops, on the edge of the forest, and in the thickets that they deserve this comparison. In the interior of the forest their flowers and leaves are barely visible. The only exceptions are the few species which love the shade, as, for example, certain lianas of the Pandanus and Arum families (Freycinetia, Pothos scandens), which I saw in the forests of Western Ceylon, and which wrapped the tree-trunks as though with closely-twined feather boas, while the closely-packed, graceful, green, fan-like leaves were waving in all directions.

Generally speaking, however, it is the stems of the lianas that catch the eye. It is the stems that make the tropical forest resemble a maze of scaffolding; it is the stems that give the forest, in Haberlandt's words, "a three-dimensional extension," whereas a European wood is one-dimensional, growing only in one direction, from the ground upwards.

And since all over the forest the lianas hang from the boughs like long ropes, there is something mechanical in its appearance. One seems actually to feel the pull of these taut cables. It is as though a giant had stretched these cords in order to turn the forest into a monstrous loom.

VI

EPIPHYTES AND PARASITES

If we compare the beech-woods of Europe with a solemn Gothic cathedral, the tropical forest will remind us of a well-lighted Baroque church, where every pillar bears sculptured figures, and the coloured decorations run up to the ceiling, whence singing or trumpeting angels look down from amidst garlands of flowers.

For in the well-lighted tropical forest every tree is adorned, at every possible point, with other plants, which often bear magnificent flowers. And since in Europe we know them as hot-house plants, it is really quite natural to compare the forest to a gaily decorated hall. Those plants which affix themselves to other plants are known as *epiphytes*. They are sometimes called pseudo-parasites, for a genuine parasite sucks the life-blood of its host, and the epiphytes are harmless plants, which merely quarter themselves on their host, and do not harm it in any way.

Like the lianas, the epiphytes contribute very largely to the peculiar charm of the tropical forest, giving it that strange and alien quality which distinguishes it at the first glance from a European wood. It is true that even our trees are not entirely without guests. In the crotches of the boughs the bark and wood often rot, and seeds wafted thither germinate. In such positions we find such plants as often turn a thatched roof into a garden; above all, the grasses, and willow-herb, and dandelion, and other plants whose seed is wind-borne.

But fungi, mosses and lichens also grow on our woodland trees. Examine the lichens growing on the trunk of an ash; you will be surprised by the number of different species. The lichens often paint our trees as prettily, for example, as they have adorned the stately trunks of the alley of Royal palms in the botanical gardens of Rio. There we see a marbling of hundreds of tones, and the eye notes with delight that these majestic stems, which in their noble simplicity remind one of the columns of a Greek temple, are individually beautified as though by the patina of ancient bronzes.

Since our woods contain only one true parasite, the mistletoe, and no specialized arboreal species of the higher plants, the tropical forest must afford conditions for the evolution of arboreal plants which do not exist in a European wood. And we shall not be mistaken if we conclude that these conditions are those which account for the presence of the lianas. The intenser light, uniformly distributed at all levels, and the sparser foliage of the trees, favour the growth of the epiphytes. The botanist Schimper tells us that the dense-foliaged trees of the Brazilian campos have no epiphytes, and that the thinner the foliage of the trees, the more numerous are their epiphytic guests.

Another condition for the growth of arboreal vegetation is humidity of the atmosphere and frequent rainfall. Since the epiphytes grow high up on the boughs they cannot absorb the moisture of the soil. Consequently the greatest number of epiphytes are found on the slopes of the mountains, on which the passing clouds shed their moisture, or in valleys where the air is constantly humid. In Ceylon I found the greatest number of epiphytes on the south-western slopes of the central range, where it rains every day about noon. In Brazil too the rain-forest of the coast contains many epiphytes, whereas in the dry regions of the wilderness the boughs of the trees are generally bare. Winter is of course a hindrance to the development of epiphytes. Many of our European plants survive the winter although the plants themselves die down, but then the roots retain their vitality in the warm earth. On the boughs of the trees the roots would be exposed without means of defence to the storms and frosts of winter. But if the epiphyte wished to become an "annual"—that is, if it intended to die every autumn and leave only its seed to survive the winter—this seed would have to remain on the tree for more than a year, enduring wind and rain and snow, and to resist the efforts of the rain to wash it away.

Lastly, the epiphytes must find suitable lodgments on the boughs. Such lodgments are more abundant in the tropical forest than in our northern woods, for the boughs are more massive and more numerous; moreover, they often bend sharply upwards, and develop rugosities, and the constant humidity leads to the formation of chinks full of vegetable mould. Many trees, like the fig-tree, extend their boughs for yards in a horizontal direction, supporting them by means of aerial roots; and the horizontal spans of the lianas afford a suitable lodgment, as do the spiral twists of their shoots. The tropical forest is a scaffolding, and a scaffolding naturally affords many places of lodgment.

But the plants which adopt the life of epiphytes must adapt themselves to these conditions. Since all things living evolve, we must suppose that even the epiphytes were once terrestrial plants, as many

Bromelias are to-day—for we find as many species on the ground as in the trees—and rooted in the ground, as are all our European Orchids. Schimper has observed that only a few families of plants have yielded epiphytes, but that these families have produced quite a considerable number. Foremost among them are the Ferns, the Orchids, the Bromelias, the Araceae, the Gesneriaceae (relatives of the Gloxiniae), and the Vaccinaceae (relatives of our Bilberries).

First of all, the plants must be able to reach the boughs of the trees. On the thatched roof of a labourer's cottage we often find quite a number of plants of different species, whose seeds are provided with the means of floating in the air. But a thatched roof has a large surface, and retains a flying seed without difficulty; the branch of a tree, which is often smooth, is a very different resting-place; yet it is necessary for the seed to adhere to it.

There are consequently epiphytes whose seed is contained in a berry which is eaten by birds or monkeys. The seed is voided, and adheres to the bough with the excrement in which it is contained, and which protects it from desiccation. This is the case with many of the Araceae, Bromeliaceae, Gesneriaceae, and other plants. Or the seed may be equipped with hairs which wrap themselves round the branch, or the plant itself may be so thready in form that it may be seized by the wind and cast against a bough, round which it coils like a *bola* or native lasso. As we shall see, the Greybeard Bromelia behaves in this fashion (Fig. 7).

Lastly, the seed may be so small that it blows away like dust, and lodges in the chinks of the bark. Such minute seeds have enabled the Orchids to people the trees, and of the 15,000 species of this order more than half have become epiphytes. It has been calculated that a single seed of one species of Orchid weighs only two-millionths of a gramme, and that of another species one two-hundredth of a milligramme. This minuteness has a second advantage: the seeds are produced in great numbers, which increases the probability that at least one seed may reach a suitable position. Even our Spotted Orchis produces 180,000 seeds.

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The Orchids, from our human point of view, stand at the highest point of a process of evolution which has constantly been producing fresh and attractive combinations of colour, scent, and artistic form. Many botanists also place the Orchids at the end of the vegetable system, as they now, reversing their earlier decision, place the plants with parallel-veined leaves, like the grasses and the palms, after the plants whose leaves have a vascular network. In this instance it would be difficult to disagree with the *scientia amabilis* of botany, for the most beautiful and wonderful forms of plants are those which conclude the classified system. As Warburg says, reviewing this system in his *Pflanzenwelt*, no family of plants exhibits such a wealth of interesting vital phenomena as the Orchids, and their blossoms are masterpieces of incomparable delicacy.

And truly, all those qualities with which a flower can bewitch the human senses have been lavished on the Orchids; we can well understand why there are not only amateurs, but also scientists, who give them their undivided attention. They produce flowers of all sizes, and even whole racemes or panicles of blossom; there is, for example, a species in Borneo which has trails of blossom more than twelve feet in length. Many Orchids are scented, and as regards their colour we find the most varied mixtures; as for the shape of the flowers, we have here an extraordinary range, passing from the most delicate and decorative beauty (Fig. 14) to the most daring and fantastic forms. In order to find graphic names for such blossoms we have had to borrow comparisons from the animal kingdom, and just as in Europe we have the Bee Orchis, the Bird's-Nest Orchis, and the Spider Orchis, so in the tropics we have the Hooded Dwarf, the Viper's Jaw, etc. But one beautiful Orchid, which is like a white dove—a native of Panama, which has often been praised by the poets—is known as the *Espirito santo* or "Holy Ghost."

While as a general thing the flowers turn skywards and let the sun shine into their chalices, the Orchids look straight into our eyes with their enigmatical faces (Fig. 14). Of course they are not really looking at us; it is the insects which they wish to attract, sending their fragrance abroad on the air, that its winged inhabitants may check their flight and alight upon them. This fragrance is often the only thing that tells the wanderers in the forest that there are Orchids in the neighbourhood. In the forest of Pernambuco the air was often full of the powerful scent of jasmine, but look where I might I could see no trace of Orchids; they must have been somewhere high in the tree-tops. The surest way of finding Orchids is to look on the ground, for there lie the Orchids which have fallen to earth with the rotten boughs on which they were growing. With practice, of course, one may detect them in the trees, but one has not always an Edysio available. (Edysio was the name of the agile student who accompanied me, climbing the trees with the help of the lianas, and scrambling down with the rotting boughs on which the Orchids were growing.)

Tuberose, vanilla, lily of the valley, rose—every kind of scent is emitted by the Orchid family, from the faintest aroma to the stupefying fragrance of the American Stanhopea. And not only butterflies, bees, and beetles are attracted, but flies as well, for the Orchids which have need of them taint the air with the stench of goats or of carrion.

Once the insects have entered the cloud of perfume and fly towards its source, they cannot miss the brightly-coloured flowers which have summoned them. There are few flowers which give such an impression of offering themselves in generous surrender as the Orchids. With their strikingly shaped and coloured petals they seem to wave to us as though with wings, and from the widely-opened blossom the "underlip" is protruded, covered, as a rule, with hairs, as a convenient alighting-place (Fig. 14). As we shall see in Chapter XIII, the Orchids are fertilized by insects, for the latter convey the male pollen to the female stigmata.

When fertilization is accomplished the petals fall, and the fruit develops, in the form of an elongated capsule. During the dry season this capsule opens, the seeds fall out, and are borne away by the wind. Many of the Orchids have developed a special device in the capsule which prevents the seed from falling out in damp or rainy weather, when the wet seed would drop to the ground. In these capsules the seed is surrounded by a sort of felt, consisting of very fine hairs. These are so constructed that they absorb the moisture in the air, and at the least increase of humidity they twist themselves and curl up in the most curious fashion. When a dry wind opens the capsules the hairs begin to fluff themselves out, expelling the seeds lying among them, which are then carried off by the wind. In damp weather the capsules close, and the hairs and seeds are imprisoned.

For a long while attempts were made to raise the magnificent tropical Orchids from seed in our European hot-houses, but when the seeds were sown in earth they failed to germinate. A French botanist was the first to solve the puzzle. For its germination the seed of the Orchid needs the help of a tiny fungus, which is found, like a microscopic network, wherever Orchids grow. The seed of the tropical Orchids germinate only if laid upon orchid mould, or on soil which contains such little fungi. On germination a minute green nodule appears, as transparent as glass, which takes hold of the soil

THE GAVEA, FROM THE SHORE

THE GAVEA, FROM THE TIJUCA FOREST

with tiny rootlets. In a state of nature these rootlets carry the fungi along with them. Such a mutual dependence of two different organisms is known as *symbiosis.* There are many other woodland plants whose roots need the assistance of filamentous fungi; and the Lichens always consist of two different co-operating organisms, namely, of fungi and algae, which are plants of an inferior order.

When an Orchid that perches on a bough begins to grow, the first thing that it has to do is to anchor itself, and this it does with its roots, which penetrate the chinks of the bark in all directions. In other Orchids the roots are ligulate or strap-like, holding them so firmly that when the Orchid is torn from the tree portions of the bark come with it. But the Orchids do not put forth holding roots only. In the Brazilian tribe of Oncidium a long mane of white, hair-like roots hangs from the bough on which the plant is seated. The whiteness of these roots is due to their dead and porous outer stratum, which, like blotting-paper, sucks up every drop of liquid, and even absorbs the moisture of the atmosphere. Such Orchids are consequently able to grow upon the smooth trunks of palm-trees, from which the rain runs off so quickly that other plants have no time to absorb it in sufficient quantities. But the roots of these Orchids suck it up immediately, and the inner, living portion of the root is able to convey it to the plant at its leisure. In a protracted drought these porous, air-filled coverings protect the inner portion of the root from desiccation. In a sense, therefore, the sheath of the root fulfils the function of the soil.

The aerial roots of some Orchids do not hang downwards, but thrust themselves outwards or upwards into the air. In the hill country of Ceylon I found the Dendrobium, whose shimmering blossoms lifted themselves from a great besom of bristling aerial roots. Such roots may even serve the purpose of aeration; there are actually Orchids in which the roots turn green and help to build up the tissues of the plant, work which is properly that of the leaves. But these Orchids have lost their leaves, and the flowers grow directly from the roots.

Many of the Orchids have developed their leaves into reservoirs. In such cases the tissue of the leaf stores water, and lays up a provision of nutritive material, so that the leaf becomes fleshy and swollen. The work of building up the body of the plant is performed only by its green outer surface. Orchids with such leaves remind one of Cacti, and the significance of such formations is the same in both groups of plants; in either case a hard outer skin preserves the contained moisture. In other Orchids the leaves are thin, and the reservoirs take the form of tuberous thickenings of the stalk.

Orchids which grow on the branches of trees have no moist earth beneath them, and are thus obliged, like the Cacti, which are natives of dry and sun-steeped areas, to take up the necessary moisture and protect it from evaporation. And the more effective their reservoirs, the higher can they climb the trees, and the better can they endure the immediate rays of the sun. Those which are able to flourish far overhead in the forest are, as Schimper observed, best able to migrate into the dry plains.

Just as epiphytic Orchids are able to adopt the habits of the Cacti, so, conversely, can the latter become epiphytic. In the forest of Alto da Serra there are tree-dwelling Cacti everywhere and at all levels. These belong to the family of the Whip Cacti (Rhipsalis). They look as though someone had stuck bunches of twigs into the bark of the trees. The Brazilians liken the shoots of this Cactus—which are often of considerable length, and as thick as a finger—to rats' tails, and call it "rabo de rato." Birds perch on the Whip Cactus, eat the fruits, and excrete the seed with their droppings.

Brazil must be richer in Orchids than any other country in the world. According to Warburg, it possesses 800 species of Epidendron, 400 of Oncidium, 200 of Maxillaria, and 150 of Odontoglossum. Oncidium flexuosum blooms so profusely in the State of São Paulo about Christmas that one can pick great armfuls of the flowers. The forest of Alto de Serra is full of blossoming Orchids about this season. I saw there one species which had laid its leaves, which were about the size of a halfpenny, flat against the trunk of the supporting tree, in order to protect the underlying roots from drought; it had small brown bell-flowers. Another kind, Pleurotallis stenopetala, puts forth a slender yellow inflorescence like a heron's crest. In Pernambuco the Trizeuxis surprises one by its yellowish-brown, fantastically-shaped flowers. There I came across the Vanilla, which twines its way up the tree-trunks with its green, sappy stem and long fleshy leaves; a very pretty sight. The Vanilla belongs to the Orchid family, and has become a liana.

Less numerous indeed than the Orchids, but more striking because much larger, are the Bromelias, which the Brazilians call Gravatás. They give the virgin forest of Brazil a character of its own, and whenever I think of that beautiful country the great green rosettes and fleshy leaves rise before my eyes, perched on the boughs and the trees, now singly, now in long rows (Plates 18, 27, 28). The ground too is often covered with them. The Bromelias have a rich and sumptuous appearance, and their flowers add greatly to the beauty of the forest. In many varieties the inner side of the leaves is red in colour, and the great bell-shaped flowers grow from their midst. Others have red or yellow corollas, and some produce a tall spire of yellow trumpet-flowers, each enclosed in a bright red calyx. The Coral Gravatá surprises the beholder by a sort of coral staff, round the handle of which are lateral twigs bearing little red clubs with violet tips.

The most useful of the Bromelias are the Ananas or Pineapples, which are native to South America. Those of Pernambuco, known as Abacaxi, are the sweetest and juiciest of all, and have the finest aroma.

The epiphytic Bromelias store up water in a way of their own. They do not, like some of the Orchids, use their roots for this purpose; their first duty is to anchor the plant firmly to the supporting bough, and they do this in many ways, sometimes even secreting a kind of cement, so that they are able to adhere to the smoothest surfaces—for example, to naked cliffs—and there prepare the soil for other plants. The leaves are the Bromelia's reservoir. These become thick and fleshy, and have a tough, leathery outer skin, which prevents evaporation from the juicy tissues.

But the Bromelias do not merely store water in their thick leaves; they also form regular basins which catch and hold rain-water. Where the leaves of the rosette come together—that is, at their root—they are flattened, and their edges are raised, so that the widened portion is spoon-shaped. Here the water is caught and stands, and since all the leaves form a closed circle, a regular pot or basin is produced, which contains a considerable amount of water. If one tears off a leaf one is deluged with water, often amounting to a couple of pints. In these miniature pools there are small crustaceans, predatory insects, salamanders, and even fish, and a special "Gravatá frog," a little creature two-fifths of an inch in length. And always, in the reservoirs of the Bromelias, we find the larvæ of the mosquito, wriggling up and down, and living in this natural aquarium until the insects emerge from their pupæ and take to the air. During the construction of the Panama Canal many of the workmen engaged on one particular stretch suffered from fever. Since no pools or puddles could be found, and since the carrier of the disease, the mosquito, can breed only in water, no one could understand where the fever came from until someone observed the reservoirs of the Bromelias.

But even in these aquaria the mosquitoes have their enemies, and among these enemies are not only insects and salamanders and fish, but also plants. In the forest of the Alto da Serra I often saw a charming light-blue flower with a long flower-stalk rising from the leafy rosettes of the Bromelias. These flowers belonged to a Bladderwort, and plants of the Bladderwort family are found also in our European ponds, where they lift a pretty but considerably smaller flower above the surface, while the wide-spreading roots float in the water.

These roots are covered with tiny bladders, and if we examine such a bladder closely we see that it has an opening, which is closed by a valve (Fig. 6). Since this valve rests on a little ridge, it can easily be pushed open by small insects in search of food or nourishment, but once the poor creatures are inside the bladder there is no escape, for pressure on the valve merely shuts it more securely. The little victims die of asphyxiation and starvation, and are thereupon digested by the wall of the bladder, which secretes a sort of gastric juice. The Bladderwort is thus a carnivorous plant, and the species which installs itself in the reservoirs of the Bromelias traps the small creatures which swim about in the water. By means of its long ramified runners this vegetable trap is able to creep from one rosette of leaves to another, and so continually find fresh hunting-grounds.

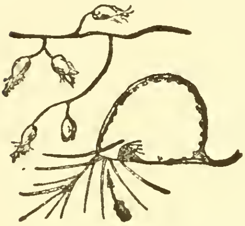

Fig. 6.—Bladder-traps on the roots of the Bladderwort. Beneath, one bladder greatly magnified. The arrow points to the valve of the entrance

The Brazilian Bromelias have flat, scaly hairs on the edges of their leaves, by which they suck up the water, which a special porous tissue conveys to the interior of the leaf. All these adaptations enable the plant, as we have seen, to settle even on bare surfaces of rock. Near Nova Friburgo I saw some great domed rocks which from a distance appeared to be sprinkled with yellow. They were simply covered with Rock Bromelias, which do not produce a rosette of green leaves pointing upwards, but only faded-looking leaves, which hang down from the plant. These catch the dust which the rain brings down with it—and so, by the way, do the epiphytic Bromelias. For even the epiphytes cannot dispense with the nutritive salts which plants draw from the soil.

However, the dirty water of the Bromelia's reservoirs contains an abundance of these salts in solution. To ensure that they shall remain in solution, and that the water shall not evaporate, the plants bring the tips of their leaves together, thus covering the reservoir.

In most of the epiphytes the roots and the leaf-insertions, which are pressed tightly against the bough, form ledges on which dust and fallen leaves are collected, whether these leaves come from the plant itself or are blown or fall thither from other plants. To these are added scraps of bark and other débris from the tree on which the plant is growing, and the whole yields a kind of humus. Certain epiphytic ferns provide themselves in this way with a sort of flower-pot full of humus, into which they plunge their roots, sending these not downwards, but sideways, and even upwards. For in many ferns the cavity in the centre of the rosette of fronds serves to collect dust. Other ferns, however, apply their fronds to the trunk of the tree in such a way that the lower edges and sides touch the bark, leaving an opening above. The rain carries dust and dirt into the receptacle thus formed, which again constitutes a sort of flower-pot. With the help of such little collections of humus these ferns grow to such a size that a single plant may weigh a hundredweight. In Ceylon I often admired the Bird's-nest fern, whose narrow fronds form a dense bush, and the Antler fern, whose fronds, waving high overhead, have the form of an elk's antlers.

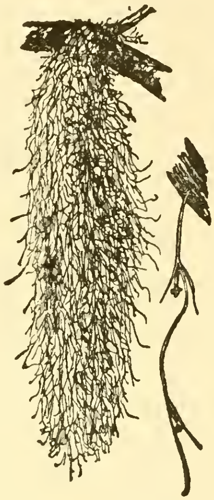

Fig. 7.—The "Greybeard," an epiphytic Bromelia. On the right, a plant in flower, enlarged. (*From nature, and after Warburg*)

In the brightly-lighted woods of Pernambuco one often sees objects like long white feather boas hanging from the boughs; sometimes as many as ten or twenty in close proximity. If we examine one of these white objects we find that it consists of long, fine threads; the Brazilians aptly call it "Greybeard," Barba da velko (Fig. 7); and when a number of these white veils are seen fluttering from the trees the wood really has a senile and moribund appearance. One would hardly believe this remarkable object to be a plant; at the most, one would take it for a lichen, and the birds appear to be of this opinion, for they use the white threads as nesting-material. But the threads continue to grow, and the nest becomes a living fabric. The "Greybeard" has renounced many of the ordinary features of a plant. It has lost its roots; we see nothing but woolly, thread-like growths from five to six feet in length, which are covered with silver-grey scales. If we examine these growths more closely, we realize that the sharply-pointed lateral hairs are metamorphosed leaves, and at certain seasons we shall even find small, slender flowers, like tiny nails (Fig. 7). Moisture is absorbed by the epithelium of the Greybeard's threads, and so one of these threads, even if it should be blown (for example) on to a telegraph-wire, is able to continue to grow there; and as a matter of fact I often saw—and particularly in São Paulo—small crinkled balls of this Bromelia growing on the telegraph-wires; a most singular spectacle.

As we have seen, the epiphytic plants are not parasites; they do not injure the tree on which they grow. But there are genuine parasites in the tropics which belong to the Mistletoe family. Their life-history resembles that of our mistletoe. The berries of the plants are eaten by birds, and sown by the birds in the branches of the trees. The droppings of the birds might suffice to make the berries adhere, but as a matter of fact the fruit contains a special adhesive substance. First of all it forms a sort of "sucker" or adhesive shield, which affixes itself firmly to the supporting bough; and there the so-called "sinkers" grow, like the teeth of a rake, down into the substance of the bough. Subsequently lateral roots are developed; these creep along under the bark, and send down fresh sinkers, and at last the plant produces boughs, leaves, and berries. But whereas the flowers of our mistletoe are imperceptible, their Brazilian relatives are splendid blossoms of glowing red or yellow, so that the tangle of branches looks as though it were bursting into flame.

The sinkers suck the nutriment needed by the plant from the bough upon which it is seated. Many species are even able to press their hosts into their service. They excrete an irritating fluid into the wounds made by their sinkers, which stimulates the bough to a morbid increase of growth. If the parasite falls off, a sort of curly, fungoid excrescence is left, which is known as Rosa de madeira.

Even on the roots of the trees we may find the most singular parasites, which have lost not only their leaves, but every trace of green. Their appearance reminds one of the tapeworm, which is able to dispense with an intestine, for in the intestine of its host it is bathed in half-digested, liquid food, which it simply absorbs through its skin. In the forests of Rio de Janeiro one may often find, in shady places, club-shaped or pointed growths emerging from the ground, in colour a fine rose-pink or red, and crinkled on the surface.

These are the inflorescence of such parasites. Their roots are incorporated, by overgrowth and interpenetration, with the roots of the trees which are forced to nourish them. The popular name for this singular, fungus-like plant is Espigo de sangue—the "Blood-spike."

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It is not to the advantage of a parasite to jeopardize the victim of its exploitation, for with the death of the host the fate of the parasite would be sealed—at all events, unless the latter had the power of transferring itself to another host. But there is one family of plants in the tropics which lives by killing. They do not suck their victim's life-blood, and it is no part of their intention to kill it, but they grow so inconsiderately that the supporting tree is simply stifled. Juristically speaking they are guilty of killing, not of murder.

And yet one is inclined to approve of the terrible names which have been given to these parasites—Matapau, "Murderer Fig," or "Tree-strangler"—when one sees such a plant before one's eyes, and notes how it encloses the supporting tree in a constricting network, so that one really feels as though the victim is at the last gasp; indeed, one almost expects to hear its death-rattle. And presently one comes upon a tree which has already died in the embrace of its executioner. The lower part of the trunk is still standing, but the upper portion, strangled and half decayed, is still suspended in the trellis, a corpse in the arms of the strangler.

The "Tree-strangler" belongs to the family of the tropical figs, and is found in the Old World as well as in the New. A bird eats one of its figs, and deposits the seed, which passes through its intestine, on the branch of a tree. The excrement holds it in place, and also provides manure, and presently a little shoot springs up, and the fig begins its career as an epiphyte. As soon as it has grown to a certain size it puts forth aerial roots, and other roots grow down along the fissures of the supporting tree, until at last they reach the ground. Now the epiphyte has become a liana (Plate 19), and can obtain all the nourishment it needs from the soil, and it grows bigger and bigger, until, in order to support its increasing weight, it puts forth lateral roots from the descending roots, which become so many stems. These lateral roots clasp the supporting tree like embracing arms, meet together on the further side, interlace, and coalesce, until the whole tree is wrapped, as it were, in a wire network, which is so tough and rigid that the tree can no longer increase in girth. This means its death; it is strangled at its most vulnerable point, where the vessels run from the roots to the crown, and presently withers and rots. In the course of time the last vestige of the tree disappears, but the tree-strangler grows unchecked on its tall cylinder of trellis-work, which is continually reinforced. Growth is added to growth, until at last the fig has a great, solid trunk, whose origin is betrayed only by the serpentine ridges running along and around its surface. On one of the hills near Olinda there was just such a Gamelleira, as the Brazilians call the "Tree-strangler" found thereabouts (Plate 19). The trunk was tall and massive, with a great crown of thick, glossy leaves. This tree stood near an old deserted monastery, whose cloisters opened on to the slope of the hill that fell away to the sea. Every Thursday the Fathers and Brothers of São Bento spent some quiet and happy hours there, and I gladly accompanied them, in order to study the plant and animal life on the slopes of the hill, or to sit on the verandah of the quiet cloister, looking across the glittering cashew-woods to the distant yellow beach, overshadowed by rustling coconut-palms, beyond which the emerald ocean lay outspread rising to the far horizon.

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With the inclusion of the epiphytes in the picture of the tropical forest we have added the final touches of colour; and now we may once more briefly define its peculiar character.

There are three features which distinguish the tropical forest from the woods of Europe: its monumental structure, the mosaic-like distribution of its details from the ground to the tree-tops, and the changing, glittering light. In the tense cables of the lianas we see the expression of mechanical strength, and the epiphytes with their leaves and flowers which meet the eye on every side, and the birds and butterflies which flutter round them, adorn all the planes of the forest with scattered colour, while the many species of trees, with their leaves of different shapes, still further enhance the variety of the scene. Falling through the open foliage of the tree-tops, the rays of sunlight, moving as the day wears on, light an ever-changing picture until the approach of night.

Thanks to these characteristics there is something gay and vital and joyful about a tropical forest; and it seems to the traveller who passes through it that the pulse of life beats more strongly here than elsewhere.

VII

IN THE DESERT

Sertão, "or desert," is the name the Brazilians give to the dry inner area of the northern States of their country.

Lonely and barren indeed are the wide, sun-steeped table-lands, and the traveller is oppressed by a sense of desolation. For the Sertão is not only empty of human life, but fresh, living Nature seems to have deserted it. Leafless the branches of the grey trees rise against the sky, and from the thorn-covered hillsides bare, round, weathered rocks emerge, and the distant ranges of hills remind one of the dead mountains of the moon.

Nevertheless, the Sertão engraves itself on the heart of those who travel through it. Like the African desert, the interior of Brazil has an indescribable atmosphere of its own, which is so individual that nothing can efface it from the memory. It is precisely in the melancholy of the desert that its attraction lies, for the human heart is more deeply moved by sadness than by gaiety, and not in vain are the greatest works of the poets tragedies.

And so we can well understand that the inhabitants of the desert —for example, the desert of the State of Ceará—are accounted the most loyal of the Brazilians. In the work of a native of Ceará, José de Alencar, the atmosphere of the Sertão and the yearning of the exile are admirably harmonized, for the author wrote his *Iracema* far from his home, and it was his longing for the Sertão that inspired him to write it. The book, of course, describes Brazil at a period when European industry had not as yet disturbed the peace of the country, when the land and the people were still one; and this unity is most delightfully expressed in the heroine, Iracema, the young and lovely Indian girl who gives her name to the book.

The German word *Hinterland* has been naturalized in Brazil. Whatever name is given to the Sertão emphasizes the contrast between the interior and the coastal belt. And this difference is explained by the geology of Brazil. The interior of the country is always higher than the coastal region. In the north-east the land rises gradually from the coast; the yellow line of the shore is bordered by the slopes of the low green hills, which increase in height towards the interior, until they merge into a vast undulating upland, some three thousand feet in altitude, traversed by ridges and scattered with fragments of rock exposed by folding or denuded by alluvial erosion. This is the "Alto Sertão."

Southwards from the State of Espirito Santo the highlands reach to the coast, and then, falling steeply away, they form, with far-flung cliffs, and nuclei of rock isolated by erosion, staring like the teeth of a giant comb at the sky, the magnificent mountain landscape of Rio. But throughout Brazil the uplands incline towards the west, sinking to an extensive plain which includes the greatest river-basin in the world. For even rivers which have their source barely sixty miles from the coast are compelled, by the slope of the continent, to flow towards the west, and so the principal streams combine into rivers of increasing magnitude, which flow towards the north and the south. The former are the tributaries of the Amazon; the latter flow into La Plata.

On approaching the south of Brazil the highlands of the interior are covered with ever-increasing stretches of grassy plains (campos), interspersed with areas of bush (catingas), and so they gradually merge into the steppe landscape of the State of Rio Grande do Sul and the Argentinian pampas. In the north-east, on the other hand, we have a singular landscape, a land of deserts overgrown by leafless woods. These are the Sertões.

I visited the Sertões of Pernambuco and Parahyba. One reaches the first by the line leaving the Central Station in Recife, and the second by that leaving the Northern Station, known as "Brum," after the picturesque old Dutch fort nearby, whose walls are reflected in the sea. One travels from early in the morning until late in the evening. The first class carriages—the second class are for coloured people—have cushioned seats covered with woven cane; the backs can be adjusted in accordance with the direction of the train, and the windows, which are open on either side, for a draught is desirable in such close confinement, are provided with sun-blinds. A dining-car provides excellent meals. Travelling, therefore, would be very pleasant were it not for the fact that in the dry season the air is so full of dust that passengers of any experience always wear linen overalls during the journey. The carriages are often worn out; they sway violently to and fro, and the constant sound of the whistle, which is blown to drive cattle off the track, is decidedly wearing to the nerves.

While in Ceylon the stations are little gems, adorned with the most delightful show of flowers—for the Government offers prizes for the most decorative railway stations—the Brazilian station seldom presents a pleasant appearance, and at every stop the hands of beggars wander past the windows or extend themselves in front of the passengers, while in many of the stations one sees shocking cases of leprosy. Swarms of pedlars with cakes, fruit, bottled drinks, and so on, drift through the train, so that one is thankful when the journey is ended.

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One leans back in one's seat, and the landscape glides past outside. From the island in which the station lies the line crosses various arms of the sea, and then passes between houses with small gardens, cutting across streets at whose level crossings motor-cars, waggons, and men and women stand waiting—many of the latter black or brown, and the women in bright green, blue or pink dresses. Now we pass the mangrove swamps already described, and the train leaves the city behind.

Meadows appear, on which cattle are grazing, and the rounded masses of the dark-green, sharply-shadowed foliage of great mango-trees with sturdy trunks. The light glitters gaily on the deep green leaves of the tall Jacas. Now—as at Macacos on the Northern Railway—the trees close in to form a shady forest. With never-failing delight the eye notes the bright trunks of the trees, the far-flung cables of the lianas, the infinitely rich and various spectacle of wild Nature; and yet this is only *capoeira* forest, which has grown up again where the virgin forest was felled, and in which no tree ever grows to be a hundred years old, since it has to furnish wood for firing the locomotives.

The landscape is growing hilly. Where the forest flows over a hill great shade-trees spread their wide boughs in august tranquillity above the crinkled crests of their lesser brethren. Fields of sugar-cane appear; it is August, and the harvest is at hand; they look like forests of beautiful, succulent green reeds. Here, in the most fertile belt of north-western Brazil, the sugar-cane, the "Brejo," is the most important crop (Plate 23).

Near Victoria station, where a memorial commemorates a victory which the Portuguese once won over the Dutch, the landscape becomes more attractive. The hills are higher and less monotonous; but they have the soft contours of the secondary ranges, though there are outcrops everywhere of primary rock, of granite. Here are ravines crossed by viaducts, rushing brooks, and tunnels. Now and again we have lovely glimpses of the forest.

From a pond comes a sound as though iron rods were being thrown down in a heap: the music of the "Alarm frog." Now fields appear, fenced here and there with dark green aloes. Other species of this plant—whose succulent, thick, green sharp-pointed leaves have a very tropical appearance—are cultivated. Their leaves yield a textile fibre. Here and there an aloe or agave sends up a stem like a mast, the top of which bears the chandelier-like inflorescence (Fig. 8). This inflorescence, in shape not unlike a pine-tree, looks like an independent plant, and one would hardly credit the tuft of leaves on the ground with the power to produce such a tree.

But the agave prepares itself all its life—which, according to the climate and the soil, may be from five to fifteen years—for this supreme achievement. The energy accumulated during these years is expended in lifting this inflorescence to a height of thirty feet or more from the ground. By the time it is fully developed the strength of the plant is exhausted; it withers, and presently only the inflorescence is left alive, and this too collapses after the fruit has ripened. It was formerly believed that the agave required a hundred years to produce its inflorescence, but we know now that it is not the agave but the Talipot palm of Ceylon that needs this long time of preparation. With its fan-shaped leaves, which are so large that one of them, bent into shape, will serve as a tent, this palm grows taller and taller as the thick stem rises from the ground and lifts its crown high into the air. So it stands, the queen of the Indian palms, its mighty fans glistening in the sun, waiting for its coronation. And now an inflorescence that seems to be carved in ivory shoots up from its summit. With this the vital energy of the tree is exhausted, the leaves droop, and the palm dies. In the animal kingdom too there is sometimes death at the summit of life. The male bee, the drone, dies on uniting with the queen, high up in the sunny air. In the case of the eel it is the female whose life ends even as she multiplies life: a subject which might well inspire a poet. In the rivers of Europe the eel—but only the female fish—lives for seven to fifteen years; a voracious eater. Then suddenly a change comes over the eel. In the grip of an overwhelming instinct, which bids

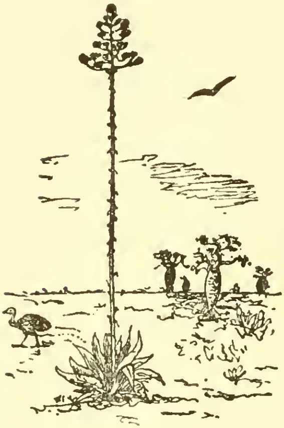

Fig. 8.—Agave in bloom. In the background Silk-cotton trees, and a Rhea

her leave her life-long home, she makes her way downstream to the sea, and after a six months' journey, during which she takes no nourishment, she reaches the western Atlantic, and there, sinking into the depths, meets the male fish, who has also found his way thither, unites with him, and lays her eggs. But even as they glide from her body the mother dies, and the young, transparent elvers must find their way alone to the rivers of Europe, without guidance, without knowledge of their course, indefatigably wandering eastward.[1]

But the train goes on, and the landscape, now more and more individual, claims all our attention. Here is an undulating country, overlooked by ranges of low hills. Here are wide open spaces, which have never known the plough; and there extensive areas of scrub or bush, which might well be called "jungle" after their Indian prototype. Here the foliage of the trees is like that of our European woods; willow-like leaves are common, but on dying they assume a vivid red colour, and hang like corals amidst the rest of the foliage. The undertone of this landscape is grey, since the trunks and branches of the trees are its predominating feature, but above them the light greenish-yellow crowns of the shade-trees float like foam, and once more one is reminded of Europe, when the inflorescence of the maple breaks out upon the grey boughs. Now fleshy cacti make their appearance, tall as trees, attracting the eye by their singular shape, while their bright red fruits, as big as a man's fist, enliven the monotone of the landscape with spots of splendid colour; and the stony slopes of the railway-embankment are covered with regiments of the Melon Cactus.

The train stops at the small town of Caruarú, which has a reputation as a health resort, for it lies 1,600 feet above the sea, and although it is scorchingly hot so long as the sun is shining, it is cool at night, so that one sleeps comfortably in a warm bed. In August the temperature is sometimes as low as 54° in the small hours of the morning, and it is said to fall as low as 50°. There is even a Grand Hotel in Caruarú, with very good Brazilian cooking, but the internal arrangements are characteristic of the country: the bedrooms have no windows, but are lighted from above, since there is no ceiling, and a common roof covers all the rooms; and this at least has one advantage, for there are no flies in the dark rooms. The beds, as usual in Brazil, have no upper sheet.

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[1] For further details see my book, *Das Tierleben unserer Heimat*, Freiburg i. Br. 1923.

I spent several days in Caruarú. The town is built round a rocky hill, which is crowned by a church. On the top of the tower is a cross, which at night blazes with electric light, shining far over the country. Such illuminated crosses are common in Brazil. There is no mean economy of lighting in Brazil, and I was often surprised, after hours of travelling through an uninhabited wilderness, to come suddenly on a little town all ablaze with light—as brilliantly illuminated as any European capital.

At Caruarú the landscape is already suggestive of the desert. There are wide open spaces, and long ranges of hills; the colouring is monotonous; even the gardens are in monochrome, and enclosed by hedges of euphorbia with cactus-like, fleshy branches. But the Sertão is still far away. We must continue our journey to the terminus of Rio Branco (or Campina Grande on the Parahyba line), as far from Caruarú as Caruarú is from the coast.

One retires to one's carriage soon after dinner and goes to bed, if there is a bed available; otherwise one sleeps in the native hammock.

. . . .

When I alighted at Campina Grande, shivering a little in the unaccustomed coolness, I was delighted to find, close to the gates of the town, a long, narrow lake, beside which I strolled all the morning, scarcely removing my binoculars from my eyes. Here for the first time I saw the rich and wonderful world of the Brazilian waterfowl.

At first there was a sandy beach along the shore; here little ringed plover were tripping to and fro, and curtsying, taking short flights; and a large brown plover flew past overhead, greeting me with a cry; and now, with fanning flight, came the "Téu-téus," the South American peewits, with crested heads and black breasts; one sees them in hundreds in the Buenos Aires bird-market. They are kept on account of the cry from which they take their name, and with which the watchful birds greet everyone who approaches; they are therefore valued as "watch-birds."

Now I was treading on a stretch of grass-covered land which ran out into the lake, a green peninsula. The bay was full of the green leaves of the Eichhornia, with their thick bladder-covered stems, which grew so closely that the leaves stood upright in dense confusion. Above the green thicket of foliage the light-blue spires of foliage nodded like bluebells; and like moving flowers the Hyacinthine Waterhens (Porphyriola Martinica) appeared and disappeared among the green leaves. The plumage of these wonderful birds is blue, merging into green on the back, and their bills are red. I saw them near Olinda too, and always with renewed delight. I never knew them to fly; if they were disturbed they hid themselves between the leaves of the Eichhornia, and some time later one might see a blaze of sapphire as the sunlight struck upon their splendid plumage.

The Hyacinthine Waterhens were always accompanied by the Jassanas. These charming birds are of the same family, but they have long, slender toes, which are still further prolonged by long claws, so that they are able to run quickly over the floating leaves of the aquatic plants, just as a ski-runner, with his long wooden skis, is able to pass quickly over soft snow. The Jassanas too have delightfully coloured plumage; from a glossy chestnut body rises a glossy, deep-violet neck, and at the root of the bill is a flame-red fold of skin. These birds are uncommonly lively, constantly quarrelling and rising into the air, when a splendid yellow shines on the wings, throwing the dark wing-tips into strong relief. The male birds perform a sort of courtship dance, flapping their wings, and rising into the air, and sinking down again. When they fly across the water the air resounds with their cries: *zip, zip, zip, zip, zip, zip, credit, credit.*

There was another waterhen swimming about on the lake, not unlike the Bald Coot, except that the white patch on the bill was replaced by red, while the black plumage was relieved by the white root of the tail and a stripe of white on the shoulder. Inconspicuous among these three waterhens was a small diver, paddling about in as lively a fashion as his European relatives, and disappearing to bob up in another place. There was also a brown duck, the Cabocla duck, whose plumage was almost plain.

Herons stood motionless as statues in the shallow water, or flew off, if I approached them too closely, with slowly-beating wings and gracefully reverted necks. I saw the Socó, a bird not unlike our common heron, and the Socó-y, a smaller bird with red-brown plumage; and there were night-herons also, squat of stature, with large heads which drooped over their white crops as though the birds were absorbed in meditation. On a post squatted a kingfisher, in shape like our own, but much larger, with blue-grey head and white collar. With a loud *plump!* he fell headlong into the water, reappearing with a fish in his bill.

Early next morning the cars which were to take us into the Sertão were standing before our house. For Campina Grande is not yet in the desert; it lies in a depression, and for this reason there was rain there in August, a thing unknown in the Sertão at this season. But the vegetation was enough to show that one was at a greater altitude than in Pernambuco. As in Europe the Alpine flora covers the ground with a carpet of many coloured blossoms, so the flowers covered the ground in the neighbourhood of Campina Grande. Red, blue and violet flowers were closely intermingled in the low growth underfoot; in some places the ground was entirely covered with the violet flowers of a kind of thyme, which gave out the aromatic smell of our northern thyme. And bumble-bees, black, with a grey thorax, flew humming from flower to flower.

Here and there, on the post of a railing, sat a little black bird with the yellow beak of a finch. Indefatigably the tiny creature sprang, with an audible flapping of his wings, perhaps a yard into the air, every time uttering a little *zip*. This peculiar dance continued, in perfect time, as though the bird were moved by clockwork, or were suspended, like a toy, on a thread of elastic. It was impossible to watch the little bird for very long without laughing, so singular did this behaviour seem. The Brazilians call this little finch the Serrador or "Sawyer," because in the distance the rhythmical *zip, zip* sounds like the regular creaking of a small-toothed saw.

The cars soon left Campina Grande behind, and were passing through a landscape whose appearance was eloquent of a scanty rainfall. This country is known as "Cariri." It is a "bush" country, and the green of the leaves is like that of our European trees, but the foliage is sparser, and on all sides the bare tree-trunks and thick grey branches are visible. Many of the plants have leaves covered with a grey felt; including Euphorbias belonging to the Croton family. This woolly covering enables the leaves to retain their moisture; at the same time, they are less likely to be eaten by grazing ruminants, as when chewed the felt comes away from the leaves and forms into pellets which irritate the mucous membrane.

Now the first tall Tree-cacti appear (Plate 21). These are the most typical inhabitants of the dry belt. Genuine children of America, they have spread from the high table-lands of Mexico far over North and all over South America, and have been conveyed, by men and birds, to other parts of the globe. Their stems are thick and swollen, and their branches have the same form. The leaves are present only in the form of small scales, or they have become transformed into spines; their green has been appropriated

OLINDA

COCONUT-PALMS IN OLINDA

by the fleshy stems, whose rind does the work of building up the tissues of the plant. The stems also store up water to be used in the dry season, and prevent its evaporation from the succulent tissues by the large amount of mucilage which they mix with it. Moreover, the skin of the cactus is very thick, and often coated with a bluish bloom of a waxy consistency. By these means the cacti defy the heat of the sun and the drought, or at most they gradually become slightly shrivelled. If segments of the lateral shoots break off and fall to the ground they begin to take root.

The peculiarity to be noted in so many tropical leaves, which grow thicker in order to protect the inner tissues from the sun, and the better to preserve the internal moisture, has reached its highest development in the stems of the cacti. But other thick-leaved plants inhabit the Sertão: namely, the Macambiras, a species of Bromelia, whose rosettes often cover the ground far and wide. Their fibres are used for making nets. There are species among the orchids also, and many kinds of Euphorbia are found even in the dry areas, the stems and stalks being thickened as in the cacti, while the leaves disappear. The gardeners call all those plants which look as though they had somehow been fattened *succulent* plants.

But there is yet another means of avoiding the loss of moisture during the dry season, and enduring the rainless months without desiccation. Plants, of course, transpire mainly through their leaves, whose broad surfaces favour evaporation, just as the water in a wide, flat saucer will evaporate more quickly than the water in a deep flask exposing but a small surface. In order to avoid losing all their moisture through their foliage, many of the plants of dry areas cast their leaves, as do our own trees in winter. It has been estimated that in Ceylon there are roughly a hundred trees which cast their foliage, for Ceylon too has dry areas in which it hardly ever rains. In the deserts of Brazil, however, all the woods are more or less leafless. When the rain falls in January all is green in an incredibly short time. A traveller once related that he fell asleep in a bare, ashen-grey wood, and when he woke in the morning he thought he must have been bewitched, for he was surrounded by billows of green foliage. Rain had fallen overnight.

Wherever there is a lake or lagoon we see lush green banks even in the dry season. Bananas with their emerald-green leaves grow in such waterside meadows, and sometimes we may see a coconut-palm that has strayed from its usual haunts: but as a rule the only palm to be found is that child of the Sertão, the Carnauba, a handsome, slender tree, the lower part of whose trunk is covered with the stumps of the old leaves, while the fan-shaped leaves of the crown wave overhead in the breeze. These palms yield the inhabitants of the Sertão almost all they need to support and shelter life: namely, timber for building, wood for furniture, palm-cabbage and sago, syrup, arrack, and fruit. With the leaves they thatch their roofs; of their fibres hammocks and mattresses are made, and a medicine is prepared from the roots. The Indians call this palm the mother of the Sertões.

Now we see another of the trees of the Sertão; at first rising above the hedges of some farm, but later growing in the open (Fig. 8). It offers a surprising, even a grotesque appearance, for the stem is enormously swollen between the roots and the crown, tapering towards the top, where it puts forth a number of gnarled and sparsely-leaved branches. It often looks like a gigantic radish, balanced upon its tip. The Brazilians aptly call these trees Barrigudas, "big-bellies."

A broad highway leads to Solidade, a place which seemed to deserve its name. But this impression vanished when we entered the comfortable house of the director of an agricultural station: a pretty, airy building, where comfort was ensured by avoiding an excess of furniture. We rocked ourselves to and fro in the customary rocking-chairs, and drank a mixture of gin and vermouth. The amiable Brazilian would gladly have kept us to breakfast, but we had to go further. And now at last we came to the real Sertão (Plate 20).

The ground is covered with yellow sand. The hills far and wide are silvery-grey with the leafless boughs of the bush-like forest. An unbroken grey sea overspreads all the hills and undulations of the ground, and the yellowish-green of such trees as still dare to show their leaves gleams here and there like the foam of breakers. There is an impressive vastness in this country, traversed by ranges of hills with jagged and riven profiles, from which the naked rock protrudes on every hand. The greyness has a lovely silvery tone, and the little white clouds floating in the blue sky cast shadows that glide incessantly across the hills, giving life and variety to the scene.

We have reached the summit of a hill. Beyond the hills before us rises a savagely serrated range, terminated in one direction by a sharp-pointed cone, the "Sugarloaf of the Sertão." A true desert range, such as I have seen beside the Red Sea, or at Aden. And like the African and Arabian desert, this grey landscape shows that it is capable of the most impressive beauty before it sinks into darkness. The sun sets in an indescribable miracle of colour. The clouds darken to deep violet, surrounded with brick-red outlines, and then grow brighter and brighter, until they are a light grass-green. The sun disappears. But here we have nothing of the swift darkness which is supposed to fall in the tropics! Just as in Ceylon, in half an hour's time it grows light again. Now the horizon flings beams of orange light into the blue-green heavens, that seem like a palpable dome overhead, and little black clouds swim in the orange glow like the spots on a leopard's hide.

Shrill screams sound from high overhead, and we see the green gleam of the parrots, returning to their distant roosting-places, indefatigably chattering and calling to one another. Here come two flying together, now nine, now ten. Now the last has flown overhead, and as the glowing colours fade the moon rises, bathing the landscape in a sharp white radiance, revealing it so plainly that one feels that one could count the trees even on the distant hill-tops.

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Santa Luzia is the name of the little town from which I made my excursions into the Sertão. A lonely stone-built city in the undulating sea of rock, Santa Luzia climbs the ridge of a hill, on the summit of which is a white church with twin towers. Going downhill, we come to a river-bed, now filled with white sand in which the feet sink, but in January it is a brown, roaring torrent, often of destructive violence.

A cotton-factory rises at one end of the town, and for three days the seven of us were the guests of the manager. Beds were provided, and hammocks hung, in a small empty house opposite the factory. Here we slept; but I sat late on the verandah gazing at the little town, glowing with electric light, and flooded with moonlight into the bargain, while a kitten caught the little beetles which rattled against the lamp and fell to the ground.

I set out on my excursions in the cool of the early morning. As a rule, the car having first taken me out into the Sertão, I continued my explorations on foot, either alone or accompanied by a mulatto who was well acquainted with the plant and animal life of the wilderness. The prospect of the grey landscape, as seen from a height, had always a peculiar beauty of its own. It was a picture in tender tones, like a Japanese painting, but here and there, like bursts of flame, glowed the splendid orange of the flowering Mulungú acacia. There is a bird, moreover, frequently seen in the Sertão, which, when it sits on a grey bough, looks like a flame. It is the Soffrer or Concliz, magnificently clad in black and fiery orange: a starling with a fine, powerful song, in whose first notes the Brazilians hear the word *soffrer* (to suffer).

Sand, and again sand! The whole country looked like the bed of a dried-up river, and I made my way along the winding depressions in the sand, in which, of course, the water flowed in the rainy season, for here I could walk at ease, whereas the bush was full of thorns. But the burs of a yellowish-grey, rushlike grass with prickly capsules—the Brazilians call it Carapicho—remained hanging to my clothes in hundreds, and if I tried to remove them the fine hairs ran into my skin. Caution is always admirable in tropical countries, and especially in the dry areas, where those plants which endeavour to retain their leaves in the rainless months protect them against grazing animals by means of thorns, prickles and stinging hairs. Once, when I was standing before a tree, and about to pluck one of its rare, sharply-serrated leaves, the mulatto pulled me back in time, telling me that if one touched such a leaf one's hand would burn for days, and indeed inflammation and fever would result. The tree was a Euphorbia, the Favelleira or "Vulture-nettle tree," Urtiga do urubú (Plate 21).

In tropical America there is yet another poisonous Euphorbia, which plays a part in Meyerbeer's *L'Africaine*. In this opera the queen of the tropical island lies down beneath the tree to die as her lover, Vasco de Gama, sails homewards. Even though the poisonous vapours exhaled by the tree do not kill, they are none the less injurious, as recent researches have shown. And from time immemorial the Indians of Brazil have prepared their well-known arrow poison from various native plants.

In the Sertão we find many trees already familiar, but more gnarled and of lesser growth than in the moist belt. From the Jucá hang great beans, like our broad beans in appearance, and swollen ridges covered with woody thorns run up the trunk of the Angico. The Braúna yields a very tough wood. The leaves of the Joazeiro will stand any degree of drought; one is always glad to see its vigorous green crown. But the handsomest tree of the Sertão is the Oiticica (Plate 21). A sturdy trunk, dividing into many branches, lifts itself from roots which run high over the ground. From the dense green roof of foliage the older leaves hang like silver tassels. It is cool in the shade of these trees; for me the Oiticicas were always oases of refreshment after hours of wandering in the blazing sun, blindingly reflected by the hot sand underfoot. I was glad to sit on the tall roots and listen to the birds in the boughs or out in the sunlight.

For I saw many birds in the Sertão. Here for the first time I was able to admire the great Brazilian parrots, in their blazing livery of blue, green and red, nibbling fruit or cleaving the air in swift and splendid flight, but quite unable at any time to hold their tongues. A characteristic parrot of the Sertão is the Jandáya, celebrated by Alencar in his *Iracema*; for long after the lovely Indian maiden is dead the bird calls her musical name in the wilderness. I was enchanted by the magnificent contrast of the green back and the yellow breast when I first saw this parrot. Here too we find the large green Amazon parrots, which we know as among the best speakers. In the Brazilian towns one often sees them sitting in the windows, where they call across the street, in an amusingly genuine Brazilian accent: "*No é? No é?*" (Isn't it? Isn't it?) Expert bird-catchers take the young birds from the nests in the hollow trees, and one day at Rio Branco I was sorry to see such a bird-catcher enter the railway-station carrying a long plank, to which two hundred of the poor little creatures were tethered.

Every moment pretty little doves fly up before the wanderers, displaying their white, black-edged wings. These are "Scaly Doves" (Rolinha cascavel), so called because each feather is bordered with black, so that the plumage seems to consist of scales, reminding one of the skin of the rattlesnake or Cascavel. Their cooing is like the call of the quail sounded on a flute: *gru gruu.*

A handsome bird whose crimson crest often enlivens the tracks of the Sertão is the Cardinal Finch or Gallo da campina. Still more splendid are the "Blue Ravens," large as magpies. The plumage is mostly black and white, but on the head is a splendid blue. Another and more remarkable bird is the "Sleeper." When first I saw this glossy-plumaged bird, flecked with black, and adorned with a yellow collar and a red, bearded beak, I was amazed. Like an apparition he sat on a projecting bough, absolutely motionless, and allowed me to approach quite closely. He really seemed asleep. But he can be lively enough, as I realized on another occasion, when a whole flock of these birds flew through the bush with loud cries of *türui, türui.* In São Paolo I saw another species of bearded cuckoo or "Sleeper," which nested in a hole in the ground, and was popping in and out of it like a rat (Plate 28).

One of the most conspicuous birds in the bush is the little brown Ferreiro or "Smith," who might more justly be called the "Scissors-grinder" (Plate 28). On every side one hears the sharp *zip*, *zip*, *zip*, *zerrip*, *zerrip*, rhythmical and penetrating, as though someone was grinding a pair of scissors in ever-increasing haste. And on almost every tenth tree hangs the great thorny bundle of twigs in whose interior the nest is concealed, and which no enemy can tear asunder (Plate 21). I shall have something more to say of this bird, which is found in all parts of Brazil.

From the sand rise the little craters of the Leafcutting Ants. These fine yellow-brown insects go hurrying in all directions, while their soldiers watch the entrance to the nest. Green-striped sand-bees are popping in and out of other little holes. Round the trees circle the great black Sand-wasps, or Hornets, their hind legs outstretched behind them. There are black bees too, which make themselves nests of mud in the middle of a bush, and of which it is wise to beware. From time to time one passes a cicada; its shrill, piping song befits the remoteness of the desert.

So for hours at a stretch one trudges through the hot sand, while the sun blazes down from the blue sky; far and wide the dazzling landscape lies outspread, and all is bathed in a hot fragrance, the mingled exhalations of aromatic herbs and withering leaves and burning sand. This heavy fragrance follows the visitor to the Sertão night and day, and never leaves him; it was this above all that made me long more acutely day by day to return to the green country by the sea.

Often a mighty wall of gigantic blocks of rock towered up before me, and from top to bottom the chinks were full of cacti of every kind, so that it looked as if someone had made a great artificial rock-garden. Here, overtopping the other trees, was the Candelabra Cactus or Facheiro (Plate 21), from whose sturdy stem a whole number of pillar-like branches projected, bending upwards near the stem to assume the perpendicular. Another kind of "pillared cactus," which the Brazilians call the Chique-chique, divides into branches on the ground, from which the short columns rise perpendicularly. It was this cactus that tore my trousers with its spines when I tried to force my way through it. A third species is the Fig Cactus (Plate 20), in which the stem and branches divide themselves into mere flat, club-shaped segments, forming bush-like masses of articulations. This cactus blooms in August; the flowers are orange. Lastly, the stone-heaps are covered with the oval or spherical Melocacti, which the Brazilians call Coroa de frade, "monk's cap," because the flame-red flower which crowns them is like the red skull-cap on the head of a priest.

If I stood quite motionless before such a heap of stones many other creatures appeared; above all, there were lizards of all kinds, which disappeared into the chinks at my slightest movement; only if I stepped back did they reappear, repeatedly nodding their heads and gazing after me with their shrewd little eyes. And the delightful brown Cavies or Preyás showed their pretty little heads and clambered over the rocks, like the rock-rabbits of Africa.

When we drove through the bush in the car we saw larger creatures too; many birds of prey, some of them magnificent; in particular we often saw a kind of vulture, the Caracará, a bird as big as a fat turkey, with variegated markings, a red and white face, and brown hood. It allows the observer to come quite close to it. A bird characteristic of the Sertão is the Seriema, a large, long-legged, bustard-like bird, at the root of whose beak a few bristling feathers stand erect. A pair of these birds ran across in front of our car, and then stood still in the bush, close beside the track; whereupon our driver stood up in the car, and before I could stop him shot first one and then the other, which was quietly looking on. I must confess that when roasted they were good eating; they tasted like turkey. Later I saw another fly up in front of the car, when I was impressed by the handsome outspread tail, barred like that of a sparrow-hawk. The Seriéma is distinguished by its shrieking cry; it lives on insects, lizards and snakes, and is often kept in poultry-runs.

The South American Ostrich is found in the interior of Brazil: the Ema, Nandhú or Rhea (Fig. 8). It may be killed only by the owner of the land on which it is found; otherwise there are no restrictions as to shooting game. On the pampas of Argentina I often saw Rheas. They live in a half-wild state, as do the pheasants in Europe. From time to time they are driven into a corral, where they are deprived of their long feathers, which are used for trimming hats and making feather fans. They are then released.

One night, as we were driving through the Sertão in the bright moonshine, foxes repeatedly ran across the track. A fox once entered the monastery garden at Olinda, and was killed there. But larger carnivora are not rare in the Sertão; above all, the "Silver Lion" or Puma, the Brazilian Onça or Ounce. While I was in Caruarú a pair of these fine animals was trapped. They sat snarling in their narrow trap-cage, and leapt against the wooden bars, spitting and gnashing their teeth if one so much as moved. Two months later I saw these pumas in the zoological gardens of Rio, when they were already quite tame. The Jaguar too occurs in the Sertão, and also its smaller edition, the Ocelot, which I once saw near Olinda. In north-eastern Brazil the black Jaguar is almost more frequent than the yellow-spotted variety, and I once saw a magnificent black jaguar which had been trapped, and which was not much smaller than a tiger. Its black coat, glossy as satin, was marked by still blacker rings.

Snakes are very abundant in the Sertão, especially such venomous snakes as the Jararaca and the Rattlesnake. Nevertheless, one seldom sees them, since they lead a nocturnal existence and hide themselves by day. The field-workers of the cotton-factory often encountered snakes; they pinned them to the ground with a forked stick, took them by the tail, and popped them into a jar. In the factory I was able quietly to observe all sorts of snakes in captivity.

As I shall show in Chapter XIX, one need have no fear of all these creatures if one should encounter them in one's excursions. In Brazil, as all over the world, only man is dangerous.

The Sertão still offers a fruitful soil for romantic tales of robbers. When I was in Recife a robber chieftain was lying in the local prison. For months he and his band had made the Sertão unsafe. He had many deaths on his conscience, and had exacted contributions from many country towns. It was said, however, that he had never harmed poor people, but had even helped them, and that he was driven to adopt his calling by some injustice that he had suffered. The countryfolk, therefore, were sympathetic towards him, and in the early days of his captivity he had no respite from the visits of his admirers. He was then sent to Fernando Noronha, the lonely island on which the Brazilian convict establishment is situated.

Many customs still prevail in the Sertão which are reminiscent of the old colonial days. One drives for hours on end through the wilderness, across the sand and through the bush, now on waggon-tracks, now over grass, and along dry watercourses, and on such journeys one learns to appreciate the tilt of the waggon, which not only protects one against the sun, but above all prevents one from being thrown out. But one gradually grows tired of being tossed to and fro, and of bumping one's head against the hood, and after

PLATE IX

CASHEW-WOOD, PERNAMBUCO

OIL-PALMS, OLINDA

MACAIBA-PALMS

a long journey one is thankful to reach one's destination, and to find that one's bones are still entire.

Far asunder in the wilderness lie the ranch-houses, or fazendas, as they are called in Brazil. A fence looms up; a boy opens a wide gate, and the blue of the sky is reflected in a storage-tank or "assude," in which, perhaps, a few men are bathing. Within the enclosure is a gentle grassy slope. Beyond this is a large courtyard, surrounded by roofed but open stalls and coach-houses; in the centre is a scrap of garden, with a bed of pineapples; directly in front of us is the house, surrounded by verandahs: on the left of the house is a white church. A number of men are standing on the verandah; in the open stalls one sees three saddled horses. The rancher or fazendeiro comes to meet us, embraces us after the custom of the country, clapping us on the back as he does so, has coffee served, and invites us, despite the many guests who are already present, to dinner; he will be only too pleased if we stay a few days. "The house is yours—*a casa é sua*," he says.

The estates of such fazendeiros, who are often very wealthy, consist of vast areas of land, mostly covered with dry bush. One estate borders upon another, and so the Sertão is all divided, and no more free land is available, though the traveller may not realize the fact; for the greater part of the Sertão is, as it always has been, a wilderness. The fazendeiro lets his cattle stray over his estate; they make their own paths through the thorny cacti and bromelias, seeking out the few green leaves. Naturally, they are not as well fed as in Europe, and the oxen cannot plough so well as ours. In the evening the cattle wander back to their stalls; if one is missing a servant jumps up and runs out, shouting and calling; if he calls in vain he returns. Often enough the beast reappears in a few days' time; often, too, it perishes, and gives the delighted vultures an abundant meal.

Cattle constitute the principal wealth of the fazendeiro. He has abundance of meat and milk, and sells both; moreover, he cultivates maize and cotton and manioc.

In north-eastern Brazil most of the free Indians have disappeared from their old home. But their blood still flows in the veins of the inhabitants of the Sertão, and with it survives the nomadic spirit of the old hunting tribes. Even in the "Brejo," the sugar-cane country of Pernambuco, the planter may build his labourers the most comfortable little houses, and may treat them as well as possible, yet one day the houses may be empty and the inmates gone, seized by the old nomadic spirit.

In the Sertão, of course, wandering may become a terrible necessity. If it fails to rain even in January, or if, as may happen, there is no rain at all for three years in succession, the last green leaves will wither, and the cattle will die of thirst in the bush. Then the little towns in the interior are left lonely; the inhabitants leave in crowds for the coast, there to lead a sorry existence.

One night, when we started about midnight, and were driving up into the hills in the bright moonlight, we met such a crowd of wanderers in the bush. Hammocks had been slung between the gnarled branches of the trees; here and there the moon shone upon a face; one man rose to look after the passing travellers. It was a scene of peculiar charm. We drove on; a Ferreiro, taking, perhaps, our headlights for the dawn, began to sing. But it was still a long time before a cold breeze, so cold that it made us shiver, heralded the coming of day, and the tangle of boughs and thickets limned itself in jet black against the glowing heavens, and the Gallo da campino in its grey and white dress, and the crimson-crested Cardinal-finch, announced that yet another day had dawned on the ancient Sertão.

VIII

TROPICAL GARDENS

GREAT flowers, that gaze into the sun beside the silent paths, blossoms glowing from the dark shrubberies, an intoxicating fragrance that rises to the tops of the palm-trees: such is the tropical garden as we have imagined it since childhood, for so the poets have seen it. And I have indeed seen a garden which seemed the very embodiment of Heine's "red-blossomed garden." When I sat there beside the silent lotus-pond, on whose further bank the forest-clad hillside rose against the sky, I seemed to hear the immortal words of the song, with Mendelssohn's harp accompaniment. It was in Ceylon that I saw this, at a height of six thousand feet, on a terrace of the central range; beneath the garden the ground fell steeply into the depths.

But Heine's description would not fit the tropical lowlands. There, in Ceylon at all events, are no "chuckling violets," no roses. In Brazil, however, much to my surprise, I saw roses in the gardens of Pernambuco, and they did very well there, although their scent was not equal to that of their European sisters. And the villa suburb of Belgrano, in Buenos Aires, is one mass of roses in October, but here again, it is said, the scent is not equal to the splendour of the flowers. I was not able to verify this for myself, as I had to leave the city earlier in the year.

The tropical garden, then, is gay with other flowers. Like the birds and the foliage of the tropics, the flowers are glossier than the tenderer blooms of Europe, and many of them gleam as though they had been varnished.

There is a Laburnum or "Golden Rain" in Brazil, but its racemes of blossom are larger than those of our European tree, and a much more luminous golden-yellow. The more characteristic of the tropical flowers have, of course, no counterpart in Europe. In India, as in Brazil, the Hibiscus (a native of Southern China) glows in the hedges and thickets; the great mallow-like flowers are a blazing red, and out of each a long pollen-covered stamen hangs. With its rose-like petals the Hibiscus is the true tropical substitute for our rose, and it always delights the eye; but it has no fragrance.

The red of the Hibiscus verges upon orange, and red and orange above all are the colours which not only shine from the flower-beds, but cover whole trees as with flame, or droop in clusters of blossom from the lianas. I have already spoken of the splendour of the flowering trees in the virgin forest, and the glorious red-flowered Mulunga acacia in the wilderness. It is only natural that the gardeners should make the most of the native flowering trees, and should also import the handsomest species from other tropical countries.

One of the most dazzling products of Nature is the flowering "Flame Acacia," the Flamboyant of Madagascar, which may be seen everywhere in Brazil and India, and even in Egypt. This majestic tree is beautiful enough even before it blossoms, for its spreading branches form a wide, shady umbel, which the large pinnate leaves cover with a green, lacelike veil. It then loses its leaves (Plate 3), but only to assume a greater splendour—in north-eastern Brazil—about Christmas. The whole great umbel decks itself with large orange-red flowers, whose five gracefully-formed petals shine as though varnished. You can imagine what a blaze of colour meets the eye when the street runs down a whole avenue of such trees! In the sunlight the tree-tops literally seem on fire.

There are many tropical trees which at their flowering season transform themselves into huge nosegays of glowing, and often fragrant, blossom, and others in which, as in the Jambo, the flowers break out of the trunk and branches, which look almost as if they were illumined from within. But where trees are planted which do not flower, or have perhaps just finished flowering, one may still introduce colour into them by twining flowering lianas round them, or by allowing Orchids or Bromelias to grow upon their trunks and boughs. The tropical gardener has an incomparable choice, and can make his garden a thing of miraculous beauty, which surprises one each month with fresh loveliness.

In view of the predominance of woody growth in the tropics, it is natural that the glorious colours of the tropical garden should be displayed, more especially by the trees and shrubs and creepers. But even the shady walks may be adorned with colour, for it is here that the Orchids are most at home. For them, too, shady arbours are built, within which they unfold their blooms on stumps of trees. Flower-beds, which in our gardens are responsible for most of the colour, do not play so prominent a part in tropical gardens. Still less, near the Equator, must one expect to find the lush green lawns without whose emerald beauty no European garden would seem complete.

Our European grasses do not, of course, thrive in the tropics; there the native varieties must be utilized, which are of a totally different character, and none of them has been cultivated for centuries with a view to making turf, as has been done with our grasses in Europe, and above all in England. A grass much used in Brazil is the so-called "pitted grass," in which the short ears are seated in little cavities. For want of something better, however, a sort of lily of the valley, known in Brazil as Gramma convallaria, is sown in lawns, for its rounded leaves grow close together, and the pretty ball-shaped flowers bloom only at a certain season.

On the heights of São Paulo I found a grass whose leaves were covered with glandular hairs, so that they had a felted appearance. They exhaled a smell reminiscent of pot-herbs; it was very insistent, and reminded me of the wilderness, which has a similar smell. The Brazilians call this grass Catingueiro, from *catinga*, which is the word used to express the characteristic odour of the negro.

At greater altitudes, where a more temperate climate prevails, the gardens are more like those of Europe, and it is possible even to make lawns and cultivate flowers like those we have in Europe. In such gardens red and orange are no longer so predominant as in the lowlands, and blue more frequently meets the eye. Even in wild Nature blue prefers the heights; for example, the most beautiful blues are frequent in our Alpine flora.

In Brazil the blue convolvulus catches the traveller's eye even on the railway embankments of São Paulo, where its fine turquoise-blue trumpets open in their hundreds. But if we journey from Rio to the three delightful mountain resorts of Petropolis, Therezopolis and Nova Friburgo, the landscape, no less than the cooler air, will often remind us of home. Petropolis, lying at a height of 2,600 feet above sea-level, always reminded me of Baden-Baden (Plate 17). When I first visited this charming little town I found the dignified silence of the place peculiarly refreshing; for then the motor-roads had not been carried up into the hills, and instead of the obtrusive, noisy, and often evil-smelling motor-car, only the peaceful clatter of hooves disturbed the silence, and the journey from the station to the town was made in cabs not unlike the old London hansom. A whole network of valleys diversifies this friendly mountain landscape; and as far as the confines of the town a straight watercourse runs down the middle of each valley, accompanied on either side by a road overshadowed by handsome trees, and beyond each road is a footpath and a hedge, behind which lie beautiful gardens, which slope upwards, gently at first, and then more steeply, until they meet the forest which covers all the heights.

In November all Petropolis was a symphony in blue. The lawns, surrounded by inviting summer-houses, were gay with the sky-blue blossoms of the Hortensia shrubs: a picture of the most luminous purity. In the foreground were often long rows of a South African lily, whose trumpet-shaped blooms, arranged in umbels, were likewise a beautiful blue. Above them, like stately candelabra, were the solemn Araucarias, whose pungent, resinous fragrance, blending with the cool mountain air, filled one's heart with the joy of life.

But even in these Brazilian hill-stations I was conscious that the soul is an instrument attuned to its native landscape—that only its native airs can elicit its finest harmonies. In Nova Friburgo I visited the park, which lay beside the charming country-house of my amiable host. It was a beautiful park; a pretty little house stood amidst little lakes above whose surface nodded aquatic flowers; roses were blooming everywhere; other flowers shone amidst the shrubberies; and in the background three bare green peaks rose above the lofty tree-tops. And suddenly I found that my heart was singing for joy in the sheer beauty of it all. I looked around me, and I realized that I was walking through an avenue of maples which skirted one of the lakes. The sun was shining through the yellow leaves; a scent of autumn was in the air; and suddenly with overwhelming force the thought possessed me: After all, how beautiful is Europe!

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In aiming at effects of colour the tropical gardener has not only flowers but leaves at his disposal. In Chapter XIII I shall speak of plants which surround their inconspicuous flowers with garlands of coloured leaves, and one cannot imagine anything more splendid than the leaf-rosettes of the Parrot-bush, a species of Euphorbia, which sets the gardens of Rio and São Paulo aflame. But for bordering paths and shrubberies there are also the coloured and handsomely-marked leaves of arums, which hang perpendicularly downwards, so that they form a kind of hedge which seems to be covered with brilliant tapestries. Certain Dragon-trees too form attractive border-plants.

And now for the palms. What a wealth of magnificent forms are at the disposal of the tropical gardener! What majesty there is in these lofty columns, what rich and varied greys cover these stately trunks! When I saw such an avenue in one of the streets of

Rio I thought of the pillars of San Lorenzo, which came from an ancient temple, and are now to be seen in a narrow street in Milan.

But majesty is not the only quality of the palms. There are palms of the most graceful form, which make pleasant green thickets between the trees of the garden (Plate 32). Like the jets of a fountain the stems of the Bamboo-palm shoot from the ground. The dense thickets of these palms remind one of the cane whose name they bear, but on drawing near one recognizes the pinnate palm-leaves, which in this species point upwards, while the midrib curves downwards at various angles. In such a thicket the cane-like stems gleam in pleasing tones of brown or orange, while the leaves, like gracefully-curved combs, reach out in all directions, and glitter in the sun.

Thickets of Bamboo-palms often line the path leading from the garden door to the house. Their glittering green harmonizes pleasantly with the reddish sand, and they turn the path into a leafy alley, through whose roof jagged splashes of light fall on the ground. At the end of the path white steps lead invitingly to the verandah of the house. And here too the visitor is greeted by graceful palms, growing in green tubs, while between them, on the railing, are bushy growths of the finely-divided, light-green fronds of the Venus'-hair fern, and from the roof hang pots of flowering creepers, or orchids look down with their enigmatic, richly-coloured blossoms. It is pleasant indeed to sit on such a verandah, where the white benches are shrouded in the green shadows of all these plants, and even one's white suit seems washed with a green vapour. The house is like a summer-house; the garden seems imperceptibly to enter the very rooms; and herein lies the unforgettable charm of the tropical home. This charm is enhanced by the animal life: the butterflies which float through the verandah on dusky blue or red and yellow wings, the humming-birds, which suddenly hang motionless before a flower, humming and glittering with bronze and green lights, often within arm's-length of the delighted observer. Even in the centre of the city of São Paulo I could enjoy the sight of these tiny birds if I sat in the shadow of one of the potted plants on the verandah.

The tropical gardener cannot do better than follow Nature, which always excels human art. It is a mistake for a European gardener, who has not yet become attuned to the spectacle of the tropics, to attempt to lay out a garden. But if the gardener takes Nature as his teacher his garden must display the chief characteristic of the tropical vegetation—namely, variety. And what variety can be achieved, even with the mere forms of the trees! There are trees which are dome-shaped and pyramidal and umbelliform in every degree; there is the flat roof of the fig-tree, and the Guapuvuru, with its huge, pinnate, fan-shaped leaves, like a great tree-fern.

Then the boughs may be adorned with epiphytes of all kinds, or hung with lianas; and all these must surely evoke a feeling of romance for the infinite wealth of tropical Nature! Animals too may enliven the scene. There is a whole host of lovely birds which need no invitation to visit the garden. From the fruits of the stilted Pachimba palm in the botanical gardens of Rio hang the gaily-coloured Rainbow Tanagers, and above the trees of the Orta da Luz in São Paulo fly green parrots or parroquets with blue wings and tails, which disappear, chattering, into the dense clumps of Bromelias which grow upon the boughs. In any Brazilian garden whose owner is sparing of powder and shot one may enjoy the sight of many birds and animals.

The Brazilians are themselves fond of animals, and it is a pretty custom of theirs to keep captive birds and animals in their parks. The magnificent storks, the white, red-throated, black-headed Jabirus, must, of course, have one of their wings clipped, as in our zoological gardens, but among them the Agoutis, with their golden-red coats, run about on the grass, stooping their pretty short-eared little heads to pick up the bread thrown to them. In the public park of Rio whole flocks of these golden hares form a graceful adornment to the banks of the lakes in which the lotus blooms, and even the queen of the Amazon, the Victoria regia, outspreads its enormous leaves. Across the lawns of the Jardim da Luz in São Paulo the Seriemá stalks with meditative steps, Jacús sit on the branches, and many other birds and beasts may be admired, which seem to live there as though in freedom. The Sloths (Plate 27) are comfortably at home in a garden, since they live on the foliage of the trees, a diet that never fails, and it does not occur to them to leave their park or garden, for these animals are not given to wandering. On the Avenida Paulista in São Paulo a little piece of forest has been preserved, which now serves as a park. Here I saw no fewer than five Sloths; sometimes they were mere brown balls, looking not unlike a bees' nest, suspended high in the tree-tops, and sometimes they clambered from branch to branch, laying their claws like hooks around the boughs, their long-haired bodies following. There were Sloths in a park in the centre of the city of Santos, and in one of the public squares in Recife. In such gardens, too,

MANGROVE FOREST NEAR RIO

URUBÚ VULTURES

SWAMP-CRAB

one sees the pretty little Saguim monkeys, peeping out of the thickets with their gnome-like faces. All these creatures soon lose any fear of man, and so the garden becomes a little Paradise, full of a peace to which even the human mind becomes attuned.

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Variety and abundance are the characteristics of the tropical orchard, as they are of the tropical garden, for in the tropics there are hundreds of species of fruit-trees, and even externally they present an incomparable variety of form.

A Mango-tree, with its gnarled and sturdy trunk and its expansive crown, on which the long, lancet-shaped dark-green leaves grow in starry rosettes, is a most impressive sight. And when the great fruits dangle from the boughs, as though suspended on strings, it has the look of a decorated Christmas-tree (Plate 22). And the fruit, the mango—or manga, as it is called in Brazil—delights the eye by the brilliance of its rind; in particular the *Manga rosea*, which is the loveliest, if not the best variety. This large fruit, ending in a blunt, curved point, is washed with pink and yellow; sometimes the pink lies over the yellow like a network.

Whenever I ate a mango I racked my brains to define the flavour of the fruit. At last I came to the conclusion that the yellow, very juicy and rather slimy pulp has a flavour of gherkin, apricot, and egg, with the addition of just a dash of turpentine. Many tropical fruits employ such a means of self-preservation, and despite this curious addition the mango is one of the most delicate fruits imaginable. The green mango, *Manga espada*, has hardly any flavour of turpentine; it is more acid, and less fibrous. After eating mangoes one must not drink milk or alcohol, or serious illness may result; on the other hand, water may be taken. It is best to be cautious in respect of all the tropical fruits, and the newcomer will do well to acclimatize himself for six months before eating mangoes, or jacas, or abacaxis—as the pineapple is called in Brazil. Further, it is important that both the fruit and the eater should be cool; it is dangerous to eat fruit that has been hanging in the sun directly it is plucked from the tree. The Brazilians prefer to eat fruit in the morning, even in their bath: a custom which has its advantages, for then the juice of the fruit cannot spoil their clothes. The juice of the cashew-fruit, a relative of the mango, of which I have already spoken, leaves an indelible stain.

Other relatives of the mango are the Cajás or Balsam-plums;

golden-yellow fruits which vary in size from the bigness of a plum to that of an apple. They have a sourish, aromatic flavour, and a faint smell of turpentine. The fruits of a Japanese tree, which the Brazilians call simply plums, *ameixas*, have also a sourish-sweet flavour. This tree is grown in the highlands of São Paulo; its apricot-yellow fruit is like the Mirabelle plum or the Italian medlar, which is the nearest relative of this "woolly medlar," the leaf of which has a yellow, woolly underside. But one must not allow the pleasant flavour of this fruit to tempt one to excessive indulgence, as a newcomer of my acquaintance learned to his cost, for the Japanese medlar is a powerful aperient. So is the fruit of the Zaboticaba, which grows in the more temperate regions of Brazil, but also in the Sertão of the North-east; a handsome, wide-spreading myrtle-tree, whose globular fruits, about the size of the Mirabelle plum, sit close on the trunk like dusky pearls. If one bites the distended skin it bursts with a little crack, and the white, juicy pulp gushes into the mouth. It is sweet, and has the flavour of the black currant. One spits out the large stone.

Among the absolutely overwhelming variety of Brazilian fruits it is possible to select a graduated series, ranging from those which are powerful aperients to those which have a constipating action, so that one can regulate the activity of the intestine by suitable doses of natural physic: a very important matter in the tropics, where a regular action of the bowels is essential to good health.

Since most of the tropical fruits are extremely sweet, one is thankful now and then to come across a really acid fruit. Such a one is the Pitanga, a pretty, angular fruit of a luminous red, which gleams in the hedges, and with which the paths in the Benedictines' garden in Olinda were bordered. In the woods of the Corcovado there is a raspberry, finer in appearance than our European raspberry, but less rich in flavour. The orange-red Kaki fig is beautiful to look at; it is much cultivated in the south of Brazil. The fruit is unusually succulent and sweet, but unless it is perfectly ripe it draws the mouth.

On the branches and trunk of the mighty Jaca tree, always a cheering sight with its deep-green, glittering foliage, the bright green, prickly fruits, large as melons, present a very strange appearance (Plate 22). If one cuts one of these great fruits in two one finds a number of kidney-shaped kernels, each surrounded by a slimy, fibrous yellow pulp, which is sweet and very aromatic, like scented cream; but the stomach easily rebels against it. For that matter, many of the tropical fruits seem more like the work of the confectioner than natural products. The same may be said of the Abacate. This fruit looks like a large pear, for which reason it is sometimes called the avocat-pear. It is cut in two, the large, round stone is removed, and the cavity is filled with red wine; the whole is sprinkled with sugar, and the creamy, tender, aromatic pulp is eaten with a spoon. Or the pulp may be mixed with ice in a glass, when one can enjoy its bright green colour; while some prefer to pepper the fruit and eat it as a vegetable.

Another South American tree which produces a delicious fruit is the Anona. This too has a pulp like the finest, sweetest aromatic cream, and a hard stone which must be extracted before eating the fruit. In Brazil there are three principal varieties: the Pinho, so called because the green or bluish fruit reminds one, by reason of the prominences on its rind, of a pine-cone; the Ox-heart, Coracão de boi, a larger fruit, with scales that give it the appearance of being covered with network; and the Cherimolia, which grows at higher altitudes than the other two.

When I arrived in Pernambuco, in July, I was able to enjoy the Sapotys, fruits with a rough, horny shell, stony kernels, and a very sweet, almost liquid pulp, whose flavour reminds one of a sleepy William pear. Among the Sapoty-trees Genipapas were growing. The large fruit has a rather astringent pulp; mixed with water it yields a cooling drink, and later, when the lemons gave out, it provided an acceptable substitute.

I can give the reader only a faint idea of the great variety of the Brazilian fruits; a list even approximately complete would require a volume to itself. And to these one must add the European fruits which have been naturalized in Brazil. The whole country abounds with oranges, even to excess, and this excess is apparent in the manner of eating the fruit; the peel is cut away with a sharp knife, whereby, of course, a good deal of the pulp is wasted. The flavour of the oranges and tangerines of Brazil is inferior to that of the European fruit, but they are richer in sugar, and often contain more juice; this is the case with the famous Bahia oranges, which are unusually large, and devoid of pips; the pips are contained in a little "daughter orange," which is situated in the upper part of the larger fruit.

There are also bitter oranges, which are eaten after dinner, for their laxative properties; as is the bitter grape-fruit. As for lemons, I was delighted to find, in the garden at Olinda, the small, spherical, light-green lemon, which has a flavour far excelling that of any other variety; it is, moreover, full of juice, and almost devoid of tissue.

I had already made the acquaintance of this lemon in Ceylon, and I found that this fruit alone was worth a voyage to the tropics. For the sake of its scent I used always to pick one and take it to my room.

Apples of all kinds, and cherries, and strawberries, do well in the highlands, and in the south of Brazil, and in Argentina the cultivation of pears and peaches is rapidly increasing. Jam or marmalade is made of all sorts of fruits, and in Brazil such preserves are a more important article of diet than with us, as cheese is eaten not with bread or bread and butter, but with jam or marmalade. The best preserve for the purpose is *guayabada*, a guava jam or jelly. The guava is a small pear-shaped fruit with a very delicate, rather musky flavour.

Very delicious and refreshing is the fruit salad, which consists of a mixture of sliced fruits. The salad is made of whatever fruits happen to be available, but the pineapple is the most important ingredient, as its aroma imparts the most delicate flavour to the whole. The pineapple flourishes best of all in Pernambuco, where it attains an incomparable lusciousness and sweetness.

A great variety of "lemonades" are prepared from the fruits of Brazil. Of this anyone can convince himself who will pay a visit to the lemonade-seller who has a little stall in the middle of the great Avenida of Rio. My favourite lemonade was perhaps that which is prepared from the passion-fruit or Marocuyá. When the round, yellow, hard-skinned fruit is cut it reveals a reddish pulp, so succulent as to be almost liquid, full of little seeds, which are something of a nuisance when one eats it, but which sink to the bottom of the glass. This fruit has a deliciously acid flavour, and a very strong scent, which defies comparison, and clings for a long time to the fingers. It reminds one very vaguely of musk, though I cannot bear the scent of musk, whereas I am very fond of the scent of the passion-flower.

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Of the fruits which are such usual articles of diet that they may almost be regarded as vegetables, the tree-melons are the most important. In Brazil they are known as Mamãos, on account of the milky juice which exudes from the orange-red pulp; for the Indians, however, they are masculine, being known as Papajas. The tree is more like a tall stake than a tree, for it has no branches, but is crowned by a bush of large, hand-shaped leaves, each on a stalk of its own. Beneath this crown of foliage are large numbers of the melon-shaped yellow fruits, their size varying with the species (Plate 28, *right*). The fruit is always welcome at breakfast, as the milk which oozes from the pulp is very beneficial, being rich in pepsin. It has a delicious melon-like flavour, and is incomparably sweet—at all events, in the north-east of Brazil; southward of Rio it is eaten with sugar, which seems ridiculous to the inhabitants of Pernambuco. The Mamão is available all the year round in never-failing abundance, and although I ate it every morning I never tired of it.

But the most important of all the tropical fruits, perhaps the most important of all the fruits in the world, and also, probably, the oldest, which was cultivated by man even in prehistoric times, is the banana. The Banana or Musa family contains no less than forty species, and of these there are again many varieties, so that the European can form no idea of their number, nor even of their flavour, since the finest of the tropical varieties will not stand transport. There are dwarf bananas (Banana nana) with large fruits, and large bananas with small fruits. One kind has pink pulp, and tastes exactly like our raspberries; others have an incomparable and excessively delicate flavour; some are more succulent, others floury, and they differ too in their degrees of sweetness. The "mealie" bananas are not eaten raw, but are baked or boiled; their flour is made into bread or cakes. In Ceylon a most savoury rum pudding is made with bananas. The amiable Benedictine sisters of Carnarú, whose parent house is Tutzing on the Starnberger See, gave us, after a genuinely Bavarian dinner of roast pork with sauerkraut and home-brewed beer, a sort of apple-dumpling, but the apples were replaced by bananas.

Since the fruit of the cultivated banana contains no seed—a sign of immemorial cultivation—the plants are propagated by means of shoots. The banana, which is not a tree, but merely a tall bush, flowers only once, then produces its fruit and dies. From the underground runners, however, new plants spring up, and by means of such propagation as much as two hundredweight of fruit may be obtained from a single plant. Since the "tree" itself, with its great, succulent, bright-green leaves, is very ornamental, and genuinely tropical in appearance, it is sometimes set out, in summer, on European lawns as an ornamental plant. The great leaves are held together only by a marginal nervure, which is often broken by gusts of wind, when the leaves are shredded to the midrib, and offer the wind no further resistance; otherwise the whole plant might be torn from the ground. The leaves of the palms are pinnate by nature, but the banana-leaf is reduced to the pinnate condition by the wind.

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Rich as the tropics are in fruits, they have few useful vegetables. True, southern Brazil has our peas and cabbages and the like, but northern Brazil possesses, as a genuinely tropical vegetable, only the quiabos; long, green, pointed fruits, which in flavour are like tender green peas. They are rather slimy in consistency, but to me they were always welcome. A vegetable of the most delicate flavour, far excelling our asparagus, is the palmito or palm-cabbage, prepared from the shoots of various palms. The best is prepared from the Palmitojussará (Plate 13), which is common in São Paulo. This excellent vegetable is eaten either baked or boiled.

The most important of the Brazilian vegetables is the black bean, which is said to be more readily digested than ours. It is the basis of the national dish, *feijoada*. This floury bean is cooked with *xarque*—that is, dried meat—which gives the dish a strong and peculiar flavour; or in the Sertão *carne do sol* is employed—that is, meat dried in the sun. Many other ingredients are added: above all, herbs and pepper. No Brazilian meal is complete without a jar of small green and red pepper-pods steeped in vinegar, which acquires and increases the excessive pungency of the pepper. My friends used to tell me that when I was able to eat this pepper without stumbling out of my chair with streaming eyes, I should be a true Brazilian!

In the tropics, where virility develops earlier than in Europe, and declines more rapidly, such pungent herbs and spices are greatly valued. It seems, however, that spiced or peppered dishes agree with one better in the tropics than in Europe. In India, for example, curry is indispensable, especially in the national dish of curry and rice, or "rice-table," as it is called in the Dutch Indies. Personally, I prefer the latter to feijoada. First one is given a helping of white rice; then four curried dishes are offered—flesh, fish, game and vegetables—and a spoonful of each is laid on the edge of one's plate. One then mixes them all together with a spoon, with the addition of a little mango chutney, and sprinkles coconut meal over the whole to soften its pungency; after which one eats the mixture, which can be varied a little every day, with the result that one never tires of it.

Just as the Italian sprinkles grated Parmesan cheese over his food, so the Brazilian sprinkles *farinha*—mandioca meal—over his. It is sprinkled over the feijoada until the black stew is white and dry. This meal, which is never absent from any Brazilian table, is derived from one of the most important plants known to men, the manioc (Bitter Cassava). The manioc is a Brazilian plant. From time immemorial the Indians have known of its uses, and even to-day they have tales which tell how their ancestors discovered it. And it is really something of a miracle that these primitive people should ever have discovered the fact that the tubers, which grow at the bottom of the trunk, attaining a length of twelve to eighteen inches, are edible, for in their natural state they are poisonous, since their milky sap contains hydrocyanic acid. For the manioc belongs to the Euphorbias, and we have already made the acquaintance of several poisonous plants of this family, so that one would not be inclined to trust any plant from which a white milky sap exudes. The Indians, however, have learned how to roast the tubers, thereby expelling the hydrocyanic acid, and even among the white population, particularly in the interior of the country, one finds everywhere roasting-furnaces of an ancient pattern, built in the open air and protected by a roof; for in the Sertão, and even more so in the wilds of Amazonas, meat and manioc are almost the sole diet of the inhabitants.[1]

The manioc shoots up very quickly, stifling the weeds that grow beneath it, so that the shoots may be planted even in an untilled meadow. One always sees the jungle-like fields of manioc in the neighbourhood of the huts of the field-workers, between the large plantations of sugar-cane and other crops, and the delicately-fingered manioc leaves are beautiful to behold.

Another kind of manioc (Sweet Cassava), *aipim*, whose tubers are known as *macacheira*, is not poisonous. The long tubers are boiled and eaten like potatoes, for the true potato, which the Brazilians call the English potato, *Batata ingleza*, does not thrive in the tropics, and is not grown north of Rio. Nevertheless, its home is in South America, where it grows on the slopes of the Andes, but in the cooler altitudes.

In the case of the manioc tubers the long fibres inconvenience the consumer. This peculiarity is absent in the other tropical substitute for the potato, the "sweet potato," *Batata doce*, the tubers of a climbing plant; but these floury, very sweet tubers, as large as a man's fist, cannot be compared with the potato. The same may be said of the Bread-fruit, *Frutta pão*, the fruit of a sturdy tree, whose large, glossy, digitated leaves give it a monumental appearance (Plate 22). It can readily be grown from shoots. The white pulp of the great beaded fruits is cut into slices and fried; it is a good substitute for fried potatoes. If it is eaten daily, however, one soon tires of its rather insipid flavour.

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[1] The starch extracted from manioc is the tapioca of commerce (Tr.).

I might speak of a pumpkin with orange-coloured pulp, a favourite vegetable in Brazil, or of the artichokes and gherkins; but I will now conclude this survey, in which, as regards the fruits of Brazil, I have not attempted to do more than mention the most important. Most of the uncultivated trees even, including the palms, have edible fruits, so that the forest provides the wanderer with many delicacies unknown to us in Europe; and in the botanical gardens of Rio the fruit often lies in such quantities on the grass that whole troops of children might feast on it. In this fruitful country, and especially in the north, the feeling prevails that it would be unbecoming to rebuke anyone who, on passing a garden, should reach over the hedge and pluck fruit in order to eat it. The opinion, deriving from a freer and wealthier age, or perhaps from Paradise itself, that the eating of fruit is a human right, is not yet extinct in Brazil.

THE EDGE OF THE FOREST, ALTO DA SERRA

EDGE OF BARREN LANDS PERNAMBUCO

FOREST SOUTH OF RIO

IX

PLANTATIONS

The principal wealth of Brazil consists of its great plantations, and the planters, the *fazendeiros*, are gentry who live in great style and have a decisive influence over the political life of their country. *Fazendas* is the name by which the great plantations in the south and the interior are known; the estates on the north-eastern coast, which cultivate sugar-cane chiefly, are called *engenhos*, while the smaller fruit-farms are known as *chacaras*.

There are, of course, only certain staple crops which can be cultivated on the grand scale. Cereals do not play a leading part in Brazilian agriculture. Although wheat thrives in the southern States, the Brazilian consumer depends principally on the wheat of the Argentine, one of the great wheat-exporting countries of the world. Rice, too, though it is cultivated in several States, does not mould the landscape as it does in India; for Brazil has no systematic system of irrigation, such as has existed in India for thousands of years, and rice, of course, is an aquatic plant, which has to be planted under water. The wonderfully luminous bright green of the terraced ricefields in Ceylon adds greatly to the beauty of the landscape; there the ricefields represent the lawns of the lovely park-land, full of coconut-palms, mangoes and other fruit-trees, which adorns the whole western coast of the island.

Maize, on the other hand, is widely cultivated in Brazil. This essentially American plant, which was cultivated in Mexico and Peru long before the discovery of America, is still grown in the primitive fashion by the Indians—for example, in the interior of Matto Grosso. They burn a patch of forest, until even the tree-stumps are consumed, make holes in the ground with a pointed stick, drop in the seeds, cover them with earth, and wait for the harvest. The first settlers, who obtained the cereal from the Indians, cultivated maize in this fashion. Even to-day there are large areas of Brazil which have not yet adopted the plough; the mattock, the *enxada*, is still the most important agricultural implement, and many a settler who hoped to find European methods of agriculture in Brazil has found himself, to his disappointment, compelled to work under the most primitive conditions, which make the greatest demands on physical strength.

Maize is often planted in rows in the midst of other crops—cotton, for example—which has the advantage that the vermin that injure either crop are prevented from spreading by the other. Maize may also be planted alternately with black beans.

We now come to four very important plants, which yield beverages in general use. In southern Brazil, particularly in Rio Grande do Sul, an excellent grape is grown. I have always drunk the red wine of the country with appreciation; it is not so heavy as the Mendoças of the Argentine, which is as heady as the Spanish vintages, but is an excellent table wine, and retains the flavour of the grape in unusual purity.

Cocoa has been cultivated in America from of old, and before the coming of the Spaniards was grown from Mexico to Peru; indeed the words "cocoa" and "chocolate" are of Mexican origin. In Brazil the great cocoa-growing State is Bahia, for the cocoa-tree is a tropical plant, and indeed a denizen of the forest, and even to-day it is found growing wild in the "inundation forests" of Amazonas and Orinoco. This tree, then, rising to a height of some thirty feet, with its glossy leaves and fleshy fruits growing out of the trunk—like a lemon in shape, but much larger, containing within the almond-shaped cocoa-beans—must be grown in the shade. It is first planted under bananas, but when the shoots attain a certain height they must be protected by the shade of taller trees, preferably those of the Leguminosae family. Climbing plants, too—namely, vanilla-vines—are grown in the wood, so that a cocoa-plantation excels all others in beauty. During my stay in Ceylon I took the greatest delight in the sight of the cocoa-woods; when the rays of sunlight drifting through the pinnate foliage of the shade-trees fell on the great leaves of the cocoa-trees their colour often reminded me of the autumn foliage of our European trees. The beans are first subjected to a process of fermentation, and then dried, after which half the fat contained in the beans is expressed, and exported as cocoa-butter.

Chinese tea, which the Brazilians call Indian tea, *Ché da India*, is grown only in the Organ Mountains and about São Paulo. A more important article of commerce is maté or Paraguay tea, the leaf of a tree indigenous to southern Brazil, Paraguay and the Argentine. This tree belongs to the Holly genus. It is a slender tree of no great height, which grows wild so profusely in the forests of the countries named that it has not yet been cultivated to any great extent. The twigs are cut off, drawn through a fire, and dried in the smoke. The leaves do not ferment as do tea-leaves. Maté is a much more wholesome drink than our tea, and drinkers who once become accustomed to its slightly smoky flavour cannot bear to be without it. I was told that the countryfolk of Rio Grande do Sul and the Argentine —the gauchos—would not be able to get through their heavy work without their maté; it is at once nourishing and stimulating. In the south the traveller who enters the lonely hut of a countryman is offered the drink of the country, contained in a little gourd, into which a small tube is introduced, the lower end of which is closed, but perforated like a sieve. This *bombilla* goes from mouth to mouth, and one must not offend one's host by refusing to drink.

I must mention also the Guaraná, a liana from whose seeds the natives of Amazonas prepare a stimulating drink; and many factories use the paste which results from crushing the seeds for making an aerated "lemonade." But the most important beverage of Brazil is coffee. Coffee is always offered when one pays a call in Brazil; even if one calls on a cabinet minister, coffee is served to shorten the time of waiting. It is drunk out of small "mocha" cups; it is very strong, and sweetened with the finest cane-sugar. Personally, I think this is the best way of taking coffee, and that the harmful effects of coffee-drinking may often be attributed to the addition of milk. While at Jahú, in the interior of São Paulo, I once suffered from a bowel trouble, and was advised to drink a few cups of coffee; which I did, with good results. In Brazil a cup of coffee taken late at night never disturbed my sleep, as it often does in Europe. The tropical climate may of course have something to do with the matter. The Brazilian coffee is admirable; its flavour and aroma are incomparable, and since my visit to Brazil the coffee which is drunk in Europe is no longer to my liking. There I always enjoyed the cup with which every meal ended. Once, in a restaurant, I forgot to order coffee after dinner, but the waiter brought it none the less; he seemed to regard my omission as due to a temporary mental aberration.

As regards the quality of Brazilian coffee, I remember a Brazilian assured me that just as we Germans can distinguish the qualities of different vintages of wines, so the Brazilians can name the years in which the best coffee was grown.

Sorting and treatment are of course factors of importance; moreover, transport by sea may to some extent affect the aroma. Brazil is the largest coffee-growing country in the world, and the

State of São Paulo alone produces more than half the world's supply of coffee.

On board the Brazilian steamer which took me to São Paulo I made the acquaintance of a large São Paulo landowner, and this amiable gentleman invited me to visit his extensive plantations. In December, after a long, tiring railway journey lasting from early in the morning until late in the afternoon, I arrived in Jahú, a small town in the interior of the State, and a centre of the coffee-growing area, for the plantations have already withdrawn some distance from the coast. Far and wide, until Jahú is reached, there is now nothing but grassy plains; the virgin forest has long ago disappeared; all is now waste land, except that here and there a wood of eucalyptus-trees, planted in straight lines, adds a further note of discord to the landscape. On the slope of a hill the train stopped between stations; here a spring gushed from the ground, and all the passengers rushed out to refresh themselves; the train waited until they had done so.

At last we came to the clean little town of Jahú, with two churches, one of them a stately Gothic building, its broad, straight streets, and its pretty parks. The town runs downwards to a little river, on the other side of which the ground rises again, and here all the hills are covered with endless plantations of coffee. We drove by motor-car to my host's fazenda, a distance of some twelve miles. Our shirts and collars were reddened at once, for the soil consists of the famous red earth, *terra roxa*, which covers all the hills like fine red dust. When it rains the red soil turns violet. It is extremely fertile.

As far as the eye could reach, up hill and down dale, and on the furthest ranges, nothing but coffee was visible (Plate 25). The coffee-trees, in shape like oval bushes, growing to a height of fifteen or sixteen feet, with their fruit still green as yet, ran over the hills in straight lines, furrowing the whole landscape (Plate 24). At a later season the fruit become red "cherries," each containing two beans. When I saw these endless plantations of one single crop, I remarked to my companion that such a "monoculture" must be risky, for if any noxious vermin or parasite should make its appearance it would spread in all directions, finding no obstacles to its progress, and might actually destroy all the coffee plantations of São Paulo: as happened in Ceylon, in the eighties, when a fungus which grew on the leaves of the coffee-tree destroyed all the coffee plantations of the island, so that these were simply deserted by their owners. The planter laughed, and replied that coffee did not suffer from pests or parasites. I returned shortly afterwards to the north-east of Brazil, and when I came again after three months' absence the pest was already there! It was a small beetle, which had been imported from Africa, a relative of our pea-beetle; this coffee-beetle penetrated the "cherries," and both the insect and its grubs destroyed the beans. Since the whole wealth of São Paulo consisted of coffee, and various foci of the pest had already been discovered, there was great excitement, and all the newspapers contained daily reports of the damage done. I already felt so much at home in the Portuguese language that I was able to give a lecture before the Agricultural Society, which was then, upon a motion of the Society, forwarded to the Ministry of Agriculture, to be printed and distributed.

In this lecture I stated that it was certainly advisable to fight a pest by means of sprays and chemical applications, but that one must not be content with these expedients. For even if the planters succeeded in extirpating the coffee-beetle, there was no guarantee that some other and more dangerous pest might not shortly make its appearance. In the State of Parahyba the coffee-scale was already swarming, and against this all chemicals were unavailing. Therefore, while applying all the suitable immediate remedies, one must not forget that the best means of defence lay in the plant itself, just as in man the best prevention of infection and illness is robust health.

But as that man is healthiest who lives a natural life, so it is with the plants. What is the natural life for a plant or an animal? It must not only have the right soil, the right environment, and proper nourishment; it must also be in constant mutual relations with the living creatures with which it naturally leads a common existence. No plant, no animal, lives for itself alone, but only in community with other living creatures, and in the delicate mechanism of Nature one species depends upon another; one regulates the multiplication of another, but also holds its enemies in check. This I shall explain more fully in my next chapter.

Insects are fought by other insects, and by birds, and therefore these creatures must find their natural environment in the neighbourhood of the coffee plantations; then, by their constant searching of the trees, they will hinder the invasion of noxious insects. Birds, however, need trees and thickets in which to nest. Areas of natural landscape must therefore be distributed between the coffee plantations. In São Paulo the valleys are particularly suited to the growth of woods and thickets; no coffee is planted in them, as night frosts are common; but these do not occur on the uplands, which are warmed by the sun all day.

While Central Brazil yields coffee, sugar is grown in the North. It has always seemed to me that cane-sugar is not only sweeter, but also more palatable than beet-sugar; moreover, sugar-cane yields more than 2½ times as much sugar per acre, so that the advantage over beet-sugar which was won by cane-sugar during the war is not likely to be recovered by the former.

Brazil is a sugar-producing country of the first rank, and since in the State of Pernambuco the estates or *engenhos* are planted wholly or chiefly with sugar-cane, I was already familiar with this crop. Between the estates, at considerable intervals, are factories, and to these tramways or railways run from the sugar-fields. In September and October the cut cane is carried thither. During the crushing process it gives off an unpleasant odour. The sap is then boiled down in great metal cylinders; the syrup which trickles from it is run off through pipes; alcohol too is distilled. The Brazilian factories enjoy this advantage, that they have no walls, which gives them a pleasant and airy appearance. The cane is crushed also in special shops in the towns, and the milky sap is sold as *caldo de canna*; a tasty beverage, in which the green of the plant seems to enhance the refreshing flavour. I did not myself drink the rum or *cachaça* prepared from the molasses; it was too strong for me; but old *cachaça* is said to be equal to the best cognac.

A cane-field is planted by burying segments of cane in the moist soil, where they send up young green shoots. Two black beetles, not unlike our dung-beetles, make themselves unpleasantly conspicuous in the cane-fields, boring through the growing shoot in the segment of stem and hollowing it out. None the less, a new shoot commonly grows, but now the eggs laid by the beetle hatch into grubs—which the Brazilians call *pão de gallinha* or "hen-bread," because hens eat them—and these destroy the whole plant. As a defence against this pest, the ground is soaked with carbon disulphide, and the beetles are trapped at night by lanterns placed over basins of water. Here again the best means of preventing the beetle from multiplying would be to ensure the presence of its natural enemies.

The cane-fields are among the loveliest of plantations. They look like endless forests of reeds, and since reeds too grow to a uniform height they have a perfectly natural appearance (Plate 23).

How often have I wandered through these forests of reed-like canes! They clashed together high over my head; on the floors of the valleys dark water glittered, from which the blue flowers of the Eichhornia emerged; then again the green shadow moved aside, and the summit of a hill appeared, crowned by the picturesque hut of a plantation-worker, surrounded by a manioc-field and overshadowed by mango and orange-trees.

Nothing is simpler than to build such a house. A wooden frame work is erected (Plate 24), wattled, and thatched with coconut-palm leaves, and daubed with mud, and the thing is done! In front is a living-room; in the middle two small bedrooms; at the back a room used for cooking and eating. Fowls and little black pigs run about the house; a few vegetables and a little fruit are grown close at hand, and the inhabitants have what they need. Nevertheless, it often happens that the overseer of a plantation will find such a hut deserted in the morning; all will seem as usual, but the family has gone away, and no work will be done in the adjacent section of the plantation. The old nomadic spirit of the Indians has suddenly awakened in the *caboclos*, the greater number of whom have Indian blood in them, compelling them to wander no matter how comfortable they may be.

On the tramways, which run for miles through the fields, one may travel by means of a four-wheeled car, which is provided with a bench; behind the bench stand two men who thrust the vehicle forwards with long poles (Plate 24). I have often greatly enjoyed such a trolley-ride. Uphill one travels but slowly, but on descending into a valley the men draw in their poles, and then one rushes downwards at the speed of an express train, and the cool wind blows in one's face; it is a glorious experience, provided one has not the bad luck to collide with a trolley coming in the opposite direction. Light-green and glossy, the cane waves on either hand; there is a scent of cedar-oil from the flea-bane growing between the sleepers, and the slopes of the hills are covered with the crinkled tree-tops of the forest. Swiftly, with a dull rattle, the trolley passes over the plank bridges, and far below one sees white water foaming.

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Just as the sugar-cane grows in the rainy area of north-eastern Brazil, in the "Brejo," so cotton can best be cultivated in the dry Sertão. For the cotton-plant needs a dry soil and atmosphere, and will stand months without rain; needing moisture only when it is planted. When a cotton-field is in flower it looks like a field of rose-bushes in bloom—Maréchal Niel roses, for instance; for the great mallow-like blossoms of the cotton-plant are a handsome yellow (Plate 25). After fertilization the petals of the flowers fall; the seed-capsules or pods, to which the involucral bracts are still attached, grow bigger than a walnut, and assume a pointed form (Fig. 9). In the compartments of this green capsule are the seeds, covered with a thick felt, and surrounded by the long, white, tangled seed-hairs. These hairs are the cotton; when the capsule is ripe, and the five valves of its green shell spring apart, the cotton protrudes like a dense ball of wadding, while the capsule turns brown and withers. In this condition the cotton is plucked and taken to the factory, where the fibres and seeds are separated by means of special machinery. Oil is pressed from the seeds.

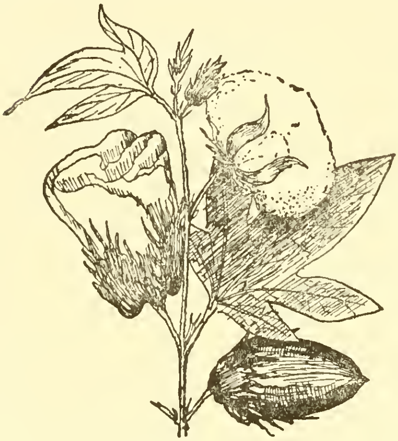

Fig. 9.—Sprig of cotton-plant, with flower, capsule, and ripe, open capsule, from which the cotton is protruding (*reduced*)

Cotton played a special part in connection with my Brazilian journey; for the pest which attacked the plantations was the cause of the invitation which I received from the Government of the State of Pernambuco. This pest is a moth, which lays its eggs on the underside of the leaves, or on the flowers or young capsules. From the egg emerges a caterpillar, which on account of its rosy colour is called the Rosy Caterpillar (Lagarta rosada). It bores its way into the capsule, and eats into its heart, with the result that the white cotton is transformed into a black, earthy pulp, while the valves of the capsule spring open prematurely.

The Rosy Caterpillar comes from India, where, however, it did little harm to cotton until American varieties were introduced. Thus this pest confirmed the experience of ages, that two forms of life which have evolved in the same country do not upset the equilibrium of Nature, but that the existence of a plant or animal is first endangered when it is confronted by an alien enemy. The same thing occurred in the case of the Phylloxera, which did no harm to the American vines, for these had evolved beside it, and had long before devised a means of defence. But when the Phylloxera was smuggled into Europe it encountered the European vine, which was unacquainted with the pest, and it destroyed large areas of vineyard. In a state of Nature there are no noxious and no useful animals; each rather contributes to the harmony of the whole; it is a cog in the great mechanism; otherwise it would not have been created.

Man disturbs the equilibrium of Nature, firstly, by introducing plants and animals to areas to which they do not rightly belong, thus meddling, so to speak, with a completed mechanism; and secondly, by perverting Nature, which is essentially many-sided, inasmuch as he allows only one particular plant to grow over wide areas of land. Thus, the Rosy Caterpillar was first smuggled into Egypt, where in 1910 it destroyed whole crops of cotton, and then into Brazil.

I very soon realized, when I began my investigation of Brazilian cotton and its pest, that in the interior of north-eastern Brazil nothing much could be effected by means of chemical warfare. A poisonous spray would not reach the caterpillars concealed in the capsule; moreover, the areas were too great for the use of sprays, and the people were unaccustomed to exact and methodical methods of cultivation. When I once told a fazendeiro that he was losing perhaps 40 per cent. of his crop through the ravages of the caterpillar, he smilingly replied that in that case he would plant 40 per cent. more.

The natural means of combating the pest were therefore indicated in this region, and in order to discover what enemies the caterpillars had, I reared them in gauze-covered breeding-cages. I discovered various Ichneumons, tiny black wasps, which puncture the caterpillar (Fig. 23), and lay their eggs in its body; these eggs hatch into larvæ, which devour the living tissues of their host until they themselves are ripe for pupation. Again, there are small Ladybirds which eat the eggs and young caterpillars; and there are also two birds, the Sebito (Plate 28, 6) and the Cagasebito, which I often saw flying from pod to pod and pulling out the shiny brown pupæ of the Rosy Caterpillar.

I was able to show that when these birds and insects were enabled to visit the cotton-fields the damage done was not excessive. This, for example, was the case in the Sertão. There the cotton-plant is cultivated simply as a sort of undergrowth in a natural environment, and the variety grown there is the "Mocó," which lives from five to thirty years, producing its pods annually as a fruit-tree bears its fruit.

In the trees and bushes surrounding the fields, and often growing in their midst, the birds were able to take refuge and build their nests, and all sorts of other creatures were plentiful, and among them were many enemies of the caterpillar. One must remember, too, that areas infested by insect pests attract birds and other insects, which assemble there as long as those pests remain to be eaten, often coming from a considerable distance, so that one asks oneself in astonishment how they could possibly have become aware of the feast awaiting them. In the same way, if one part of our body is diseased the other parts turn their attention to it; blood flows towards it, and the temperature rises.

Nearer the coast the cotton was planted in very large fields; far and wide not a wood or thicket was left standing, so there were no birds there, for their fear of hawks makes them reluctant to fly over treeless areas. And here, sure enough, all the pods were worm-eaten!

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I observed something similar in the case of the coconut-palms. My delight in seeing these beautiful trees again on my return to Recife was marred by the fact that many of them were crowned only by the bare midribs of the leaves. The caterpillar of the Brassolis butterfly was responsible for the damage. But as soon as I left the city behind me I found that the palms were flourishing in undiminished splendour. The explanation of the mystery was as follows: certain birds of the Cuckoo family eagerly devoured the long, unappetising-looking caterpillars, just as the European cuckoo eats and indeed prefers the hairy caterpillars disdained by other birds. But since the birds did not enter the city, the caterpillars were there able to do their work undisturbed, and the devastation extended to the limits of the areas haunted by the bird.

The birds which thus make themselves useful are the Anúms; long-tailed birds not unlike our magpie. One species, the Anúm branco, is spotted with brown; another is jet-black; and a third, a larger brown bird, is known as "Almo da gato," "Soul of the cat," because its cry is like the mewing of a cat. The black Anúms are common everywhere; they fly across the meadows with a loud, questioning *á-nu*, whisking their tails up and down as they alight, and search themselves, as well as any grazing cattle that may be accessible, for ticks. Their flight is like that of the paper birds which children throw into the air.

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Among the birds of Brazil one might say that every speciality is represented. If the natural fauna of the country is preserved, even in the areas of human cultivation, it will gradually adapt itself to the latter. But the natural conditions of animal life must be maintained; and this refers, above all, to the indigenous plant-life of Brazil.

For this reason it is doubtful whether further steps should be taken to afforest Brazil with the Australian eucalyptus. This tree has the peculiarity that its lancet- or sickle-shaped leaves lift themselves perpendicularly sunwards, for which reason, and because the foliage is thin, the tree casts hardly any shade. A peculiar shimmer is apparent in a wood of eucalyptus-trees, because the leaves twist at the slightest breath of air (Plate 25). In such woods the Brazilian birds can find no place of refuge, no opportunity of nest-building; the intrusion of the eucalyptus means the suppression of the indigenous plant and animal life, and the elimination of areas which, as I have already shown, ensured the health and prosperity of Nature and of the plantations. And more: the introduction of foreign plants and trees has often had disastrous consequences, inasmuch as some hitherto unremarked inhabitant of the imported plant, which did no damage to the latter, has suddenly left it for the growing plants or crops of its new home, and has destroyed them. For example, with the American vine the Phylloxera was imported into Europe; with Indian cotton-seed the Rosy Caterpillar found its way into Egypt and Brazil. On the other hand, the eucalyptus woods might suddenly be devastated by some inhabitant of their new home, as the coffee of Ceylon was destroyed by a fungus.

It has often been observed that a plant introduced or accidentally smuggled into a foreign country first multiplies enormously, and then perishes. In Ceylon I found two widely-distributed Brazilian plants, the Sensitive Plant and the Cambará or Lantana. This is a shrub with very pretty red and yellow flowers. The wife of a Governor of Ceylon had been impressed by the beauty of this shrub during a visit to Brazil; so much so that she imported it into Ceylon and planted it in her garden. She had, however, reckoned without a certain black bird, the Madras bulbul, which fancied the berries of the new shrub; and since, when he ate them, he sowed the seeds in the way natural to birds, it was not long before the plant reached Indo-China, and became a pest there, and in India too; while in 1900 it became obnoxious in Honolulu, whither it had been brought from Mexico, and where it did great damage to the sugar plantations. But in Ceylon, no later than 1911, a planter showed me with grim satisfaction a shrub which was absolutely leafless: it had been attacked by a black fungus. It was reported from Honolulu also that the shrubs had lost their leaves and flowers; and so the Cambará will disappear in India just as the American Water-hyacinth perished in Europe, though at first it grew so luxuriantly in the ponds that the fish were stifled.

This example shows how a little human interference with a very restricted area may affect the landscape of whole countries, inasmuch as Nature may see to the wider distribution of the species introduced. This should make us doubly careful of introducing alien species. Many cases of transplantation have occurred involuntarily; seeds have adhered to sacks, articles of clothing, etc. Thus, on the railway-tracks in São Paulo I saw several of our native Hawkweeds, and despite the sun our honeysuckle was blooming fragrantly among the bushes. In northern Brazil the castor-oil plant, introduced from India or Africa, was growing luxuriantly on every refuse-heap. Even on the edge of the virgin forest this quickly-growing plant is common everywhere (Plate 23).

But it is one thing if individual plants find their way into a foreign country, and quite another if a whole countryside is given an alien character.

The eucalyptus, it is true, grows with unusual rapidity, and yields useful timber, but it is highly probable that among the thousands of Brazilian species there are trees with the same qualities. The eucalyptus is known also as the "fever tree"; not because the mosquitoes avoid it, for it has been observed that they thrive in swampy eucalyptus woods, but because the tree draws a great deal of water from the soil, which is quickly evaporated by the leaves, and so the puddles in which the mosquitoes breed are dried up. This quality, however, has its disadvantages in Brazil, for the forests retain moisture, protect springs, and regulate the climate. Already the Brazilian climate is beginning to change; the rains are not as regular as they used to be, and here and there the country suffers from drought. The explanation is that great areas of forest have been destroyed; during the war, in particular, the timber in the neighbourhood of the railway-lines was cut, as there were no imports of coal, and even to-day the locomotives burn wood.

This progressive deforestation is a serious matter, and if it is not discontinued the future of Brazil will be at stake. The Mediterranean countries were once largely forest-land, and consequently fertile; to-day they have in the interior wide areas of stony highlands, and in North Africa of desert; and once the vegetable growth of a region has disappeared it is hardly possible to create it anew. May these deserts be a warning to Brazil, for otherwise this glorious country may one day become a stony wilderness.

The Brazilians ought to insist that their Government should protect the forests. They ought in particular to be preserved on the highlands and the mountain ranges, for it is there that the moisture is collected which runs down the valleys and waters the plantations. And the forests must remain Brazilian forests. It is of no use to plant eucalyptus, for this tree, as we have seen, does not retain moisture. The Brazilian trees belong to Brazil, and the forest must have the character which Nature has given it—the character of the virgin forest, for this has the best prospect of remaining healthy and promoting health. This is not to say that the forest should not be utilized; and in planting trees preference should be given to those which yield the most valuable timber. The creation and exploitation of the forests should be entrusted to a regular Department of Forestry; and the creation of such a department is a matter of the greatest importance, for the wealth of Brazil consists even more in her forests than in her sugar and coffee. We have seen what valuable woods Brazil possesses; and the possibilities of their utilization are almost unlimited.

The science of forestry would enter upon quite a new province if it were to set itself the task of maintaining and exploiting a tropical forest in the only form natural to it, with all its lianas and epiphytes.

The eucalyptus has its home in Australia. There, where it has adapted itself to a country poor in animal and vegetable life, an infertile soil, and a scanty rainfall, it is in its proper place, and in its way beautiful. But who would change the teeming, sunny land of Brazil into an Australia! To replace the virgin Brazilian forest by a eucalyptus forest would be to exchange diamonds for paste.

X

THE ANIMAL WORLD OF BRAZIL

We call America the "New World," and the word involuntarily evokes the conception that the American continent is younger than Europe, Asia and Africa, and that it must have been still slumbering on the ocean floor when the lands of the eastern hemisphere had a long history behind them. This, of course, is not the case; America was a "new world" only for the Europeans who discovered the continent some four centuries ago. The history of America is brief only in so far as the white races are concerned. The native races of South America can be traced back almost as far as the races of the Old World; indeed, the Argentine explorer, Ameghino, is even of the opinion that the Argentine may have been the original home of the whole human race. This opinion, however, has not been generally accepted, for in America we find neither the oldest type of man known to us, the so-called primitive man of the pre-glacial period, nor yet another human type, which was equally dissimilar from the Indians of to-day, and which certainly arose in remote antiquity. For these reasons the old opinion still prevails, that the inhabitants of the Americas found their way thither from the Old World, probably from Eastern Asia. But that these groups of Indians could subsequently be split up into so many races, showing fundamental mental and physical differences, proves beyond a doubt that the time which has elapsed since their migration cannot be measured by our historical standards.

As for the geological antiquity of the continent as a whole, this is plainly not inferior to that of the other continents. But in this connection the current opinion requires amendment. We speak of America as a continent, but in reality there are two continents, and North America is more closely related to Europe than to South America. This is proved by the vegetation alone. In North America the oak, beech, hazel, fir and pine entirely resemble our European trees, and California, with its cypresses, reminds one of the Mediterranean coast. Similarly, the North American lynx, fox, wolf, beaver and elk are hardly to be distinguished from the European species; and the same thing is true of all animal life. For example, if we turn to the tables of American butterflies in Seitz's great work, we shall find some—such as the Apollo, the Swallow-tails, the Lycenidae

—which are apparently identical with the European species, and others which are quite different. The first are North American butterflies, and the second South American.

What the animal life of our own period tells us is confirmed by the animal life of primeval ages. The earlier forms of Elephant which lived in North America when the northern areas had a warmer climate prove that these pachyderms moved round the North Pole in periodic migrations, and that there was no obstacle to their passing from America into Europe or Siberia. The separation of these continents by the sea cannot, therefore, be of very ancient date; ancient, that is, by the historical standards of the world of animals. For many geological ages the northern hemisphere of our planet seems to have been covered by an unbroken area of land, joining North America, Europe and Asia, while bridges of land connected Europe with North Africa by way of Gibraltar, Sicily, and the Greek Archipelago.

Turning to South America, we find that the American Mediterranean is much wider than the sea dividing Europe from Africa: the West Indies must not be regarded as a bridge, for in their formation they are equally remote from the two continents; and the same holds good of Central America, which seems at one time to have consisted of islands. As for the Isthmus of Panama, only 36 miles in width, it was first formed when both continents had for untold ages led an independent existence, and had developed an abundant flora and fauna. This is confirmed by the geologists and the zoologists alike, and by the comparison of the marine animals on either side of the isthmus.

Thus a family of corals, Fungia, is at home only in the Pacific and Indian Oceans, but one species extends into the Caribbean Sea. How can it have come thither, save from the west? Similarly, in the sea to the east of the Isthmus of Panama there are a number of sea-anemones which are unknown in other parts of the Atlantic, but have their home in the Pacific. Similar forms of sea-urchins, too, prickly, globular creatures which move by means of tubular sucker-feet or pseudopods, are found on both sides of the isthmus; and so is a species of crab, Hippa eremita. Lastly, of 374 species of coastal fish inhabiting the Gulf of Panama, no less than 54 are found on the West Indian side of the isthmus.

South America is essentially a continent of the southern hemisphere; of all the continents it reaches farthest towards the South Pole. It rose out of the water at a very remote period. Its foundation, as the Frankfurt scientist Otto Maull recently demonstrated, is a vast body of primitive gneiss, which in the course of the ages has been repeatedly uplifted and depressed. During the later geological periods the sea invaded the more depressed areas. And since in the sea the fine ooze brought down by the rivers is continually sinking to the bottom, covering the bodies of animals which have also sunk to the bottom, and preserving their harder portions, we are able to ascertain, from those remains, which are now scattered over the surface of the continent, the enfolding ooze having ages ago hardened into rock, that America has passed through all the geological epochs of which we find evidence in other parts of the world. It knew the Carboniferous, the Jurassic, and the Cretaceous periods, and the cretaceous deposits are spread all over the north-east of Brazil, which must at one time have been covered by a wide sea, in which swarmed sea-lizards of enormous dimensions. The next geological period, which we call the Tertiary, and which witnessed the emergence of the mammals, has likewise left its deposits in Brazil, as one may see on approaching the north-eastern littoral, where the steeper slopes of the coast are as white as snow. It was during this period that those tremendous foldings of the earth's crust occurred, which, to the accompaniment of volcanic outbreaks in the western part of South America, simultaneously with similar outbreaks in North America, piled up the Cordilleras.

Brazil was a quieter land than the western side of the continent, which even to-day is so subject to earthquakes. Its mainland, rising to altitudes of 1,500 to 2,500 feet in the centre, has sunk towards the basins of the Amazon and the Rio de la Plata, so that the surface waters have flowed thither to create these great river systems. The Atlantic edge of the continent, having been squeezed upwards, was eroded more and more deeply by downward-rushing watercourses; ravines were eaten out, between which the remaining rocks rose like towers and gigantic dice, as we can see to-day in the mountains on the coast of Espirito Santo (Fig. 10) and around Rio, and in the jagged outline of the Organ Mountains. Deposits of débris have once more joined the islands to the mainland—as the Sugarloaf, for example, has been joined, which was once completely surrounded by the sea, as its less lofty sisters are to-day (Plates 5, 6, 7).

We must think of Brazil, through all these periods, as inhabited by a rich fauna, which during these long ages had time to develop in independence. Thus, of the 131 species of mammal in South America, no less than 103—that is, four-fifths—and of the 920 species

SERINGAL. TREE-TOPS IN THE FOREST

SERINGAL. MASSARANDUBA TREE

of bird no less than 732—that is, five-sixths—are confined to this country. India, on the other hand, and the other countries of Southern Asia, have the monopoly of the Peacocks, Pheasants, and Hornbills, though the other families of birds native to these countries are represented, although by other species, in the neighbouring continents. Again, of 90 families of lizards, South America has 78, of 94 families of snakes 69, and of 48 families of frogs 41 which are unknown to the other continents.

All these families, however, have split up into numberless species. The Humming-birds are now divided into 400 species, of which 80 are Brazilian. A group of birds peculiar to South America, known as Tree-climbers, has evolved into a great number of species, and forms which in other continents have sprung from various families have evolved, in Brazil, from this one group. The Arapaçu, for example, with its brown wings, spotted breast and powerful bill, climbs up the tree-trunks like a woodpecker; another Arapaçu has a slender, curved, almost semicircular bill, while others resemble our nuthatch in size and behaviour (Plate 28). The Potter-bird or "João do barro" hops over the lawns like a thrush, and builds oven-shaped nests of clay in the trees. The "Bundle-nesters," such as the Curutiá, slip through the thickets like hedge-sparrows, and build wattled nests of brushwood (Plates 21, 28). Other species creep like mice over the ground, while others live on the water; and in adopting all these different modes of life the Tree-creepers have assumed a great variety of shapes and sizes. Another prolific family of South American birds is that of the Tyrannidae; of these, the Bemtevi is like our Jay, the Siriri resembles the Fly-catcher, while the "Washerwomen" haunt the waterside like our Wagtails.

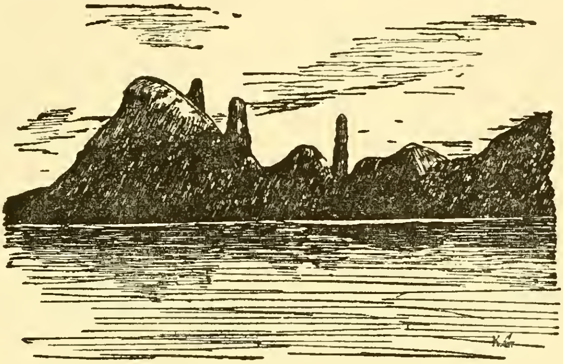

FIG. 10.—Itawira, on the coast of Espirito Santo

The same wealth of forms is found among the mammals; of the Rodents, for example, some are aquatic animals, some resemble small Ungulates, and others correspond to our hares and other species.

This extensive division of the various families has led many scientists to believe that South America consisted formerly of a number of islands, each of which evolved its own individual fauna. To this one must object that the age-long isolation of the continent, with the fact that it is divided into many different types of landscape, would suffice to explain such variety. Even to-day von Ihering distinguishes six different regions in Brazil, of which each has its special avian fauna, while other birds are common to several, and some to all regions. These regions are: Amazonas; the country to the south of Pará; the Sertão of the North-east; the interior of the southern States; the northern coastal zone, originally forest-clad; and the southern coastal zone, characterized rather by high grassy plains. The bird life of Amazonas in particular is wholly peculiar to the country.

But there is a second factor which favours the division of species in South America. This is the circumstance that the greater part of the continent lies within the tropics. A few figures will show the great difference which exists in respect of the wealth of species between tropical and temperate countries. Of the 2,286 species of fresh-water fish in the list of fishers drawn up by the London Natural History Museum, 1,552, or more than two-thirds, are tropical species. The river system of the Brahmaputra-Ganges has 170 species; that of the Mackenzie in Canada has only 23; and while the Amazon boasts of 748 species, the whole of Europe numbers only 126. And so with the birds, of which Brazil has 1,600 species, and the Argentine 887. The insect life of the tropics is especially rich in species; in India, for example, there are nearly 30,000, while in Greenland only 437 are known. Of snakes, 727 species are found in the Philippines, but in Japan, whose area is half as great again, only 193.

The explorer Bates relates that within an hour's walk of Pará he caught 700 species of butterfly. One day he caught 46 butterflies in the virgin forest, and among them were 33 separate species; on the following day he caught 37, of which 33 were of different species; and these included 27 which he had not secured on the previous day. This record says something as to the great variety of the tropical fauna. Needless to say, the more untouched by man, the more rich in variety is Nature. Multiplicity of form is the essential charac-

VIRGIN FOREST, ALTO DA SERRA. IN THE CENTRE, A PALMITO

ON THE RIO PAQUEQUER, NEAR THEREZOPOLIS

teristic of Nature; uniformity that of civilization. In our cities there are few birds beyond rooks, thrushes, blackbirds, and sparrows; the wild animals are replaced by domestic species; and even the races mingle and become more uniform, just as European customs and clothing are progressively spreading all over the world.

It is easy to see that in the tropics the transmutation of forms must proceed more rapidly than in temperate regions. We know that procreation proceeds more rapidly in a warmer climate. Even human beings reach puberty earlier in hot countries than in Europe; girls become nubile at the age of twelve. It is the same with animals, and in this respect Hesse has collected a number of observed cases. In Africa it has been found that a half-grown Kudu antelope is fertile, and in New Zealand the imported red deer become sexually mature a year earlier than in Europe. In Europe the group of coleoptera known as the Asparagus Beetles needs a year for its development from the egg to the perfect insect; but in Java it requires only 30–31 days. The East Asiatic butterfly, Danais chrysippus, produces one generation yearly in the northern parts of its habitat; in the southern parts it requires only 23 days for the complete cycle, and generation follows generation. Hesse calculates that an insect which lays 100 eggs could multiply, with a 30-day cycle, to the extent of 488 trillions in a year, while in Europe, with two generations yearly, it would produce only 5,000 offspring.

Such an intense spate of life must necessarily result in a transmutation of forms. The more profusely a fauna multiplies, the more subtly can it adapt itself to the existing conditions of life, exploiting every spot of the earth's surface. But for this new adaptations of the body and the instincts are requisite. And the more prolific development of the flora favoured by the torrid zone must equally enrich the fauna, since every plant has one or more forms of animal life dependent on it, feeding upon it or exploiting it as a dwelling-place. When we climb into the mountains we find that we are leaving behind us, with every plant that cannot thrive in the higher altitudes, certain forms of animal life.

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Despite the thoroughly individual development of the fauna and flora of South America, we must realize that its plants and animals have not evolved in absolute isolation from those of the other continents. To begin with, we must not forget that the ocean itself is not an absolute obstacle to the distribution even of terrestrial forms of life. The larger birds cover the widest expanse of water; the Virginian plover, for example, on its spring and autumn migrations, flies from Labrador to Venezuela and back again; the Stork of East Prussia migrates to South Africa; the Fish-eagle and the Egret are citizens of the world, and the Barn-owl is no less valiant a traveller, though one would never have expected it to cover such vast distances. And involuntary journeys of considerable length are often made by birds caught in a gale. No less than 46 species of American birds have been wafted over to England, while 37 European species have reached North America. The bird-watcher Gätke found on Heligoland 15 species of American land-birds.

In the same way German dragonflies and butterflies are often borne on the wind from Germany to Heligoland, and even to England. And even among the butterflies there are world-citizens; I myself found the Painted Lady on the highest mountains in Ceylon, and on the Tijuca peak near Rio. This pretty butterfly was like a greeting from my home. A Hawk-moth, Celerio linata, which dashes through the air on its narrow wings, has made itself at home in every continent, and the black and brown butterfly, Danais erippus, has in our own day invaded Polynesia (1863) and Celebes (1873), and in the other direction has reached the Azores, and according to Sietz is occasionally seen in the British Isles.

Many living creatures may be carried across the sea on drifting wood. A huge snake, a Giboia, a native of America, was once driven ashore on the island of St. Vincent; it had wrapped itself round a tree-trunk, and was full of life. The fauna of the Polynesian islands has been frequently enriched by insects, snakes, and even (it seems) by mice, which have reached the islands on driftwood. The patches of woodland along the shores of La Plata harbour a whole series of insects, frogs, and snakes of northern origin, and large snakes, crocodiles, and even jaguars have drifted as far south as Buenos Aires on the trunks of trees. On a floating tree in the Amazon, Spix and Martins saw a troop of monkeys; on another, squirrels, and on a third a tiger-cat and a crocodile. Those who, sailing along the Brazilian coast, have seen how far from shore the brown waters of the São Francisco are distinguishable, will readily believe that many an animal may drift seaward on a floating tree, until it becomes the plaything of the ocean currents, to be stranded finally on some distant coast.

But the fauna of South America teaches us that a greater exchange of species must have taken place than can be explained by these occasional and fortuitous displacements. For the similarity of the basic forms of animal life in South America and the other continents is so great that we cannot assume that they all emerged in complete mutual isolation.

For example, there are Tapirs, pachyderms with short trunks, in India and in South America (Plate 27). It speaks for the concealment in which these animals live that the large Saddlebacked Tapir was discovered in the old, civilized country of India very much later than the Anta of Brazil. It would puzzle us completely to say how these creatures should occur at two opposite points of the globe, and nowhere else, had not palaeontology told us that the Tapirs were formerly distributed over the whole of the northern hemisphere, and that the Prototapirus, regarded as the ancestral form of the group, occurred in the early Tertiary period, in North America and Europe. Thence, apparently, the Tapir wandered southwards.

In the same way the great naturalist Cuvier discovered in the strata surrounding Paris a fragment of bone which he attributed to a marsupial; an attribution which caused a great sensation at the time, for it was known that living marsupials were found only in America and Australia. The Camel tribe is to-day represented in Asia and Africa by the Camel, in South America by the Llama. The connection between the two countries is to be found in North America, where the Camelidae were represented in the early Tertiary. Certain of the Tortoises, too, had northern ancestors, and so had the great Iguanas, and in Europe, during the Tertiary period, crocodiles, pythons, lions, elephants, hippopotami, parrots, and all sorts of other creatures occurred, whose descendants are now found only in southern latitudes. During this epoch, apparently, the climate of Europe was warm. The palm-trees which are found in the Tertiary deposits confirm this assumption.

Insects lead us to the same conclusion. The termites or "white ants"—known in Brazil as Cupim—and of which more than 400 species are living to-day, exclusively in the tropics, are found in the amber of the Baltic. The great Water-bugs of India and Brazil existed in Bavaria in the Tertiary deposits, and the spiders and snakes afford similar examples.

It looks as though the original home of a great part of the animal world should be sought in the northern hemisphere, in the Tertiary period, which, with its warm climate and the manifold variety of its surface, afforded possibilities of the emergence of the greatest variety of species, while its great masses of land gave them opportunities of migration. But if this was the most prolific source of life, room had to be found for its creations, and the earlier forms were thrust towards the outer limits of the hemisphere. The older species withdrew before the newer; the oldest were driven furthest; and this explains why to-day we find the most ancient species at the southern extremities of Africa and America, and also in Australia and New Zealand—that is, in the regions of the globe most remote from the focus of their emergence.

One may ask why the older forms of animal life did not defend the soil which was their due, and drive the newer species from their proper home. But it would seem that youth confers greater energy, and that fresh modes of attack break down the firmest resistance. Just as European man has spread over the whole earth, driving back or expelling the indigenous populations in Africa, America and Australia, so twelve species of European snakes have established themselves in North America, but not a single American snake has made its way to Europe. In Australia the two indigenous beasts of prey, of the order of the marsupials—the Marsupial Wolf and the Tasmanian Devil—have had to give way to the Dingo, the yellow wild dog introduced by man—just as the indigenous Australian song-birds are giving way before those of their European relatives which have been introduced by the white settlers. In Rio, too, the pretty native Bunting, the Ticotico, is retreating before the imported European sparrow.

If now we follow the traces of these vast migrations, if we scrutinize the skeletal remains which tell us of their paths, we are obliged to assume that there was once land where to-day the ocean rolls, and that South America, in the early Tertiary period, when the principal mammalian types emerged, was connected with the northern continents of North America, Europe, Africa and Asia. For the mammals, being for the most part genuine land animals, could not swim across wide areas of sea; if they spread to other continents, it could only be by land.

Since we cannot search the bottom of the sea for the relics of the Tertiary period, we must fall back on hypotheses if we wish to reconstruct the old connecting-links between the continents. Of such hypotheses there are many. One supposes a great continent filling the southern hemisphere, and including South America, South Africa and Australia. Recently the opinion has emerged that South America may, so to speak, have broken away from Africa, since its coast fits into the Gulf of Guinea, and slowly receded across the Atlantic Ocean. A São Paulo zoologist, the late H. von Ihering, even sketched a southern continent on the map of the early Tertiary period, and a second continent connecting South America with Africa. The theory that South America received many of its animal species from the northern focus of creation, by way of Africa, has, as a matter of fact, much in its favour. The primitive forms of the Caviidae of South America occurred, in their oldest forms, in the early deposits of Europe; Africa yields a few relics of them, but North America none. Nearly related forms are found in the fresh-water fish of both hemispheres, which is a particularly striking proof of a former connection, since these creatures would never swim across the sea, nor could they be carried across it by drifting wood. Among the fishes are the incubating Siluridae, of which I shall speak in Chapter XIV; beyond a few Indian species, these occur only in Africa and South America, and the same may be said of various snakes.

Let us now consider the mammals of Brazil individually, and see what they tell us of old continental junctions.

Let us take, as one of the lowest forms of warm-blooded animals, the Marsupials (Plate 27). These animals derive their name from a pouch on the abdomen, in which the mother lays her offspring—helpless and undeveloped as a creature prematurely born—where it fastens so firmly on the milk-glands which empty themselves into the pouch that a kind of growth connects its mouth to the nipple, while the windpipe of the little creature is pushed forward almost into the nose, so that the stream of milk shall not incommode its breathing.

As primitive mammals the marsupials have been driven southwards by the continual emergence of new forms. They are found to-day in Australia and the neighbouring islands, where, being early shut off by the sea, they were able to call a halt and divide into many species, of which the best known are the Kangaroos. In South America too the marsupials have continued to evolve, though not so prolifically as in Australia; apparently because the western continent remained joined to the northern mainland after their migration, so that new competitors for space and nourishment appeared.

The South American marsupials are carnivora, which eat small mammals, birds, and insects. Only one form, the Water-Opossum, is aquatic, living on fish and aquatic insects. There is a whole series of terrestrial forms—the Mucuras, Quicas, Chichicas, Catitas—which range from the size of a marten to that of a shrew-mouse (Plate 27). Their naked tails remind one of rats, and some are even described as marsupial rats, but as a matter of fact, their tails are adapted to an arboreal life. With them the animals grip the branches, let their bodies hang downwards, seize the next branch with their forefeet, and so progress at a rapid pace. On level ground most of them move but slowly, but among the branches they are extremely nimble, as they are able to support themselves with the opposed thumbs of the hindfeet. If they are caught, they try to scare the enemy by shamming dead and emitting a noxious odour; they are able, however, to bite severely with their needle-sharp teeth.

Although the marsupials of Brazil are nocturnal animals, anyone who has spent a little time in the country will have seen the larger forms, known in Amazonas as Mucura, in the North-east as Timbú, in the South as Gambá, and in the Argentine as Comadreja; or he may have encountered a poultry-farmer who has told him, with indignation, how his hen-roosts have once more been visited by the nocturnal robbers.

In the convent garden of Olinda I made the acquaintance of the Timbús, of which a whole family was captured one by one. The mother took refuge in a hole in the wall. I made a noose, laid this about her head with the help of a stick, and drew her out into a cage that was held before the hole. I kept her for some weeks, and the young ones as well, and then released them. At first the captive shammed dead, imitating a dead animal so thoroughly that she even retracted her lips from her half-open mouth, thus assuming the suffering expression of death. Later she saved herself the trouble of this performance, but showed her teeth at once if anything displeased her, hissing like a snake. Almost directly after I had caught her she ate half a banana, and resigned herself completely to her fate, except that she paced up and down her cage at night. But she showed no attachment to her captor, and being slow and lethargic was not very attractive. The marsupials betray their position at the very bottom of the mammalian order by the fact that the temperature of their blood is not so uniformly high as in the higher mammals; which accounts for their lethargic character.

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The next group of the lower mammals which invaded South

America are the Edentata, "the Toothless," so-called because they have few teeth, or none; and from this alone we perceive that they are degenerating. He who has once seen an Anteater, with its long-haired, black and white coat and its huge plumy tail, and has watched the great creature holding its head, slender as a stick and curved like a sabre, to the ground, in order to seek its food with its worm-like tongue, will agree with Carus Sterne that it looks like a creature of hoary antiquity, no longer quite adapted to our age, whose race has been isolated by the dying out of its many relatives.

And indeed, in the Tertiary period, and even in the pre-Tertiary, the Edentata played a very different part in South America! It was with amazement that I saw the giant Armadillos and Sloths of that period in the museum of La Plata, the pleasant University town to the south of Buenos Aires (Plate 26). In a well-lighted, semicircular hall surrounding the body of the museum stand these giant creatures, some of them large as elephants, marshalled in rows under their glass cases, as though struck motionless while marching into eternity. Here, gleaming white, is the monstrous tortoise-like shell of the Glyptodon, built up of finely-chiselled plates of bone; behind it is the menacing tail, armoured with spiked rings, and before it the head is outstretched, likewise armoured with bony plates. Now come the giant Sloths, in size and weight rivalling the great Armadillos; here is the Megatherium, "monstrously lazy, monstrously large," which could never, of course, have hung from the boughs of the Imbauba-tree, as Scheffel supposed, for the slender tree would at once have been shattered by its weight! Relatives of the Megatherium, the Mylodon and the Gryptotherium, were, it would seem, kept by man as a sort of living provision for the winter, since their remains have been found in Patagonian caves, together with unmistakable traces of human occupation. Many scientists believe that man has been responsible for the extirpation of these mighty creatures, defenceless for all their size and their bony armour. Since the remains of armadillo-like forms have been found in the older Tertiary deposits in North America, and even in France, the Edentata must have found their way hither from the North, but it was only in South America that they reached their full development.

To-day three families of these creatures are still extant in South America; the Armadillos or Tatús, the Anteaters or Tamanduás, and the Sloths or Preguiças (Plate 27). Of these animals, the Anteaters are exclusively insectivorous, while the Armadillos eat fruits and roots as well as insects, and the Sloths live entirely on the leaves of trees. They are said to prefer the large leaves of the Imbauba, but as a matter of fact I found them constantly on other trees. There is a good deal of evidence to show that the ancestors of all these creatures lived more or less in the same fashion. The Sloths, it is true, have a bony process in the nose (according to Hilzheimer) which is found elsewhere only in the grubbing or burrowing animals, such as the pig and the mole. So the primeval Sloth may perhaps have thrust its nose into the ground when it dug up the soil in search of insects with the formidable claws which it possesses in common with the Armadillos and Anteaters. And conversely, the Great Anteater may once have been an arboreal animal, as the smaller Tamanduá is to-day, while the very small Tamanduá-i moves about hanging by its claws like a Sloth.

The foot of the Anteater is transformed into a powerful mattock; it has a projecting middle toe, armed with a sharply-curved claw. With this tool the animal is able to break open the nests of termites and ants, even when they consist of hardened clay. In order not to blunt this sharp claw, the Tamanduá walks on the outer edge of its forefeet, with the toes turned inwards. When it comes to a termites' nest it supports its whole weight on one forefoot, and hews at the nest with the other. The insects, always on the alert, rush out in order to drive off the enemy, but the Anteater wriggles its worm-like tongue towards them; and when they angrily bite this tongue their fate is sealed, for it is withdrawn into the tubular snout, where the insects are swept off. The mouth at the end of this snout is small, but it does not need to open wide for food of this kind, which is masticated by the horny tongue.

The Armadillos too have feet heavily armed with claws, which they use to dig themselves in when danger threatens. At the same time, the dorsal armour prevents the stones lying in the earth through which the animal is burrowing from crushing it; it is also, of course, a protection against the teeth of enemies. I kept a Tatú for some time, feeding it on bananas. Unfortunately I forgot that the animal lives in a warm burrow; it caught cold in its cage, and died.

I always loved watching the Sloths, which are not found in the forest only, for I was able to admire them in the park beside the Avenida Paulista, in São Paulo, and also in Santos. The park in question is a relic of the virgin forest, which is traversed by footpaths. In it five Sloths had been installed, and there they flourished. Sometimes I would see one hanging high in the open foliage of a tree, like a yellow ball, or rather like a wasps'-nest, a resemblance which would be a protection against birds of prey. At other times I would see it clambering down like a gymnast equipped with hooks instead of fingers. The head turns cautiously, seeking for the best purchase; it can be turned until it looks directly backwards, for the neck is very mobile in the Three-toed Sloth, since it possesses nine cervical vertebrae, whereas other mammals, including the giraffe, have only seven. I have seen the Sloth hook its way down perpendicular lianas, so firmly do its claws hold; even when the animal is dead they do not relax, so that a Sloth which has been shot often remains hanging. From time to time the Sloth slings itself along a bough and eats the leaves, for whose digestion it has a stomach divided into several compartments, in each of which the food is exploited in a different manner.

The Sloth is a fascinating creature, and although its movements are slow, they are extraordinarily certain. I once saw a Sloth which wanted to climb from a palm into another tree, but when it slung itself forward along a palm-leaf the leaf was so far pulled down by its weight that it could no longer reach the tree. Quietly it went back and embraced two palm-leaves, but as these were not rigid enough it made another attempt with three leaves, which did support its weight, and having reached the end of the three leaves, it was able to reach and grasp the nearest bough of the adjacent tree. In Santos, however, I once saw a Sloth in the grass, looking about it with its owlish face, and pushing itself along from one tree to another. Fortunately there were no dogs about.

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The next group of animals which came to South America was that of the Rodents, in which the canine teeth are lacking, while the incisors, two in the upper and two in the lower jaw, have developed into sharp cutting-chisels, which grow continually, and must be worn down by constant gnawing, since they have no roots which would otherwise limit their growth. It is these large incisors which give the animal the truncated profile by which the rodent may always be recognized. The Rodents are a very ancient order, which seems to have arisen at the very base of the mammalian family tree, for they still display many characteristics which are reminiscent of the reptiles. For example, like the lizards, they often have scales on their frequently hairless tails. The Rodents have undergone a tremendous expansion; the number of their species represents more than a third of the whole mammalian world, and their individual numbers are so great that they are the animals most frequently encountered in any part of the world, and form the most important and unfailing item of the diet of almost all birds and beasts of prey.

When the Rodents made their way into South America they found an almost virgin country. The grasses were as yet almost untouched, so that the Rodents, herbivorous from of old, were able to adapt themselves to this form of nourishment in a great variety of ways. There were, of course, in the South America of the older Tertiary period, great herbivores like our Ungulates; for example, the Toxodon, a sort of three-toed hippopotamus, and the Macrauchenia, which reminds one of the Llama, but which also had three toes; and one may see the complete skeletons of these two animals in the La Plata museum. But remains have been found of yet other species which differ so greatly from our Ungulates—whether single-hoofed or cloven-hoofed—that special orders have been established for them. Among them was the Tapir or Anta, of which I have already spoken.

But these animals, these primitive Ungulates, were apparently not very numerous, and their types, of which they were, so to speak, the forerunners, were not as yet firmly established, so that the Rodents, with their great fertility, were able to push in among them, and even to begin to supplant them. For a very characteristic South American group is that of the Caviidae, in which the nails of the toes have to some extent assumed the form of a hoof, while the balls of the toes are covered with horny callosities. These creatures, therefore, have undergone a development similar to that of the Ungulates, whom they resemble in respect of their nourishment and their rapid gait; and in size they exceed most of their relatives in other parts of the world.

Beside the Brazilian rivers lives the Capyvara, the "Lord of the Grass," as the old Indian name of Capi-i-uara means, according to Goeldi. This portly creature, about the size of a yearling pig, with a coat of long yellowish-brown hair, attempts, as far as it can, to follow the example of the Hippopotamus. If startled, it rushes into the water with a loud cry of warning. On bright moonlit nights, where the riverside forest opens to leave a grassy glade, the Capyvara may be seen grazing, or sitting up on his hindquarters like a dog (Fig. 33).

Another aquatic animal is the Nutria or Swamp-beaver, which, as its name tells us, resembles in appearance the Beaver of the northern hemisphere, except that its tail is not trowel-shaped, but like a rat's. It is found in the basin of the Rio de La Plata.

Almost as large as the Capyvara is the Paca, a rodent whose body is striped with rows of white spots. The Paca burrows in the ground, and is still found in the Organ Mountains. Its smaller relatives, the Preyás, are common throughout Brazil. The Guinea-pigs are a branch of this family, and they were domesticated by the ancient Peruvians. The Preyás themselves look like small brown Guinea-pigs; it always amused me to see them appear, when all was quiet, and look about them with their large and beautiful eyes. I was always glad to see the Mocó too, a somewhat larger form, which is found in the rocky regions of the Sertão.

Other pretty Brazilian rodents are the Cutias, Agoutis or Golden Hares, which I have not seen in a state of Nature, but only in the park at Rio. They have a considerable resemblance to the Dwarf Antelopes, or rather, Dwarf Musk-deer, of the Old World. In the southern portion of the continent, in the pampas of Patagonia, live the Viscachas, which are like Marmots, and the Maras, which resemble hares, except that their ears are short; while in the Cordilleras the Chincillas live a hazardous life, persecuted on account of their valuable skins. In the trees of the Brazilian forests there are not only pretty little squirrels, but also Tree-Porcupines, which have prehensile tails, which however they do not pass *over* a branch, as the monkeys do, but under it, curling it upwards. The quills of one species are so loosely set in the skin that they readily fall out, and being barbed, they penetrate the hide of an enemy, and finally disappear under the surface.

I ought still to mention a whole series of rats of primitive types, but in order to avoid overstepping the limits of this volume I must leave the lower orders of mammals and say something of the highest mammalian order, that of the Monkeys.

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That the Monkeys should find a congenial home in a land of forests like Brazil is only natural. But they must have arrived in South America at a very early date, for among the monkeys of the New World we find animals which are closely related to the types which must have been the ancestors of this great mammalian order, but which have now died out in the Old World. The American monkeys differ fundamentally from those of Africa and Asia. While the latter have, like man, a narrow septum, so that the nostrils look downwards, the American monkeys have a broad septum, so that the nostrils look outwards. Moreover, the monkeys of the Old World have a dentition resembling that of man, as regards the number and form of the teeth. The American monkeys, however, have an additional tooth in each jaw between the canines and the pre-molars, so that they have not 32 but 36 teeth in all. Still lower stand the Unguiculate monkeys of South America, among which are the delightful Saguims. These, as their name tells us, have claws instead of nails, even on the big toe; moreover, the thumb cannot be opposed to the other fingers, and their small intelligence is shown by the fact that they have no wisdom-teeth!

But this does not prevent the Saguims from being the most delightful animals imaginable. Fortunately they are still numerous, but are, of course, only too frequently caught, when they are offered for sale to passing travellers. For me it was a memorable moment when I first saw a Saguim. One Thursday, when the Fathers and Brothers of the monastery made an excursion to "Monte," a small, deserted monastery on the quiet hilltop, from which one had a glorious view of the cashew-woods and the sea, I joined my amiable hosts. At the back of the horseshoe-shaped building grew some cashew-trees, and it was here that I was able, on looking through the window, to observe a Saguim at my ease. The charming little creature, with his grey, woolly coat and long banded tail, would have looked like a pigmy Kinkajou but for his tiny black face, with its startlingly human, or rather gnome-like, expression, observant but slightly plaintive. The Saguim was nibbling at the bark of the cashew-tree; presently he proceeded to groom himself. Later on I often met the little creatures in the woods, and heard their sharp whistle, which sounded like a boy whistling between his fingers. They also utter a *kek*, *kek*, *kek*, like the chatter of the magpie. We shall see in Chapter XV that the Saguim ventures even into city gardens.

There are many related monkeys in Brazil, such as the Lion Monkey and the Pencilled Monkey. To these we must add the larger monkeys; the Scarlet-faced Monkey, the splendid Howler Monkeys, Bugios, or Guaribes, known by their penetrating cry, the Death's-head, and the Capucins or Micos. These latter creatures are very gentle, and their voice is a soft whisper. In the zoological gardens one may stroke them without fear of injury, or pick them up if they are in the open; I have done so constantly, and have never been bitten.

The great forests of the Amazon basin have given the monkeys a magnificent home. Here they have evolved in the greatest variety; here the great black monkey of Brazil, the Coatá, can swing himself in looping curves from bough to bough; in him the thumb, unsuited to such a mode of progression, has disappeared. The American monkeys have developed the tail into a fifth limb. They can suspend themselves by it, and use it for grasping when they leap from bough to bough. They even feel with their tails, grasping and examining their food; for on the under side of the tip is a large bare tactile area.

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Other classes of animals have evolved in South America in a special direction. Among the birds I may mention the Inhambús, which represent the partridge family, but which must, by reason of their internal structure, be reckoned among the most primitive of birds. The handsome black Hokkos or Mutúrus, with the bill adorned by a red or yellow tubercle, and the Jacús, with their red wattles, correspond to our grouse. A very singular bird is the Hoatzin of the Amazon basin. The nestlings run about on all fours like lizards, and their wings are provided with claws, the inmost of which can be opposed to the others like a thumb, and these little creatures swim, and even dive, using their wings as flippers, like the penguins of the Antarctic.

In Brazil the Macaws or Araras are the finest of all the representatives of the parrot family; and it is only in South America that we find the equally resplendent Toucan with its gigantic beak, as to whose purpose we are still in the dark. Among other South American birds I must mention the splendid blue Cotingas or Anambés, the Tyrants, the Arapaçus, and the Humming-birds or Colibris.

I shall speak later on of the reptiles and batrachians, but I may mention here that the peculiarly individual nature of animal evolution in South America is revealed by the fact that of 90 species of lizard, 78 are confined to this continent, and of 94 species of snake 69. Of the 48 South American batrachians 41 are exclusively South American. It is in Brazil that the evolution of the batrachians has been most prolific and various. Coming to the fresh-water fish, we find that one particular family has filled all the places which in Europe are filled by a variety of groups—such as carp, roach, trout, pike, etc. These are the Characinidae. To this family belongs the terror of the Amazon and other Brazilian rivers, the Piranha. With its sharp teeth this terrible fish, which attains the length of the forearm, tears whole pieces out of the flesh of swimming animals, and since the Piranhas appear in shoals directly they scent blood, the victim is soon stripped to the bones. The Piranhas and not the crocodiles are the real danger in the Brazilian rivers. But the Candiru, a little thread-like Silure, is an equally unpleasant acquaintance. This creature forces its way into the urethra of bathers, and owing to the spines on the gill-covers it cannot be extracted.

The Electric Eel or Poraqué is another Brazilian fish; on either side of the spine this fish has developed electric batteries, a shock from which will stun a horse. And in the Arapaima of the Amazon the world of fresh-water fish has its largest representative.

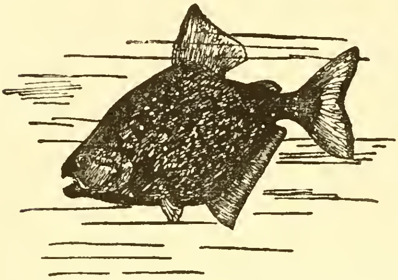
FIG. 11.—Piranha, one-sixth natural size

The number of insects in Brazil is almost infinite. Nowhere else are there so many species of butterflies; and the vivid blue loveliness of the Morphidae is not excelled by any other butterfly on earth. Among the Coleoptera we find those amazing giants of the beetle world, the Hercules Beetle and the Elephant Beetle. Even the bugs have evolved magnificent forms in Brazil.

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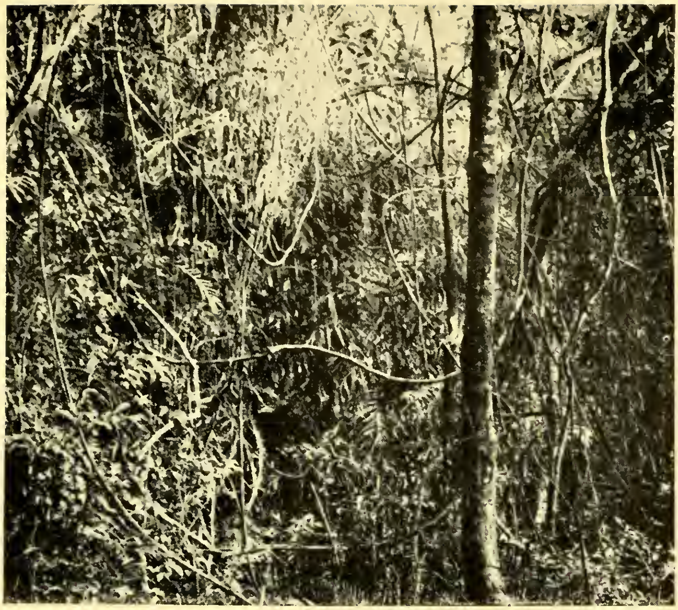
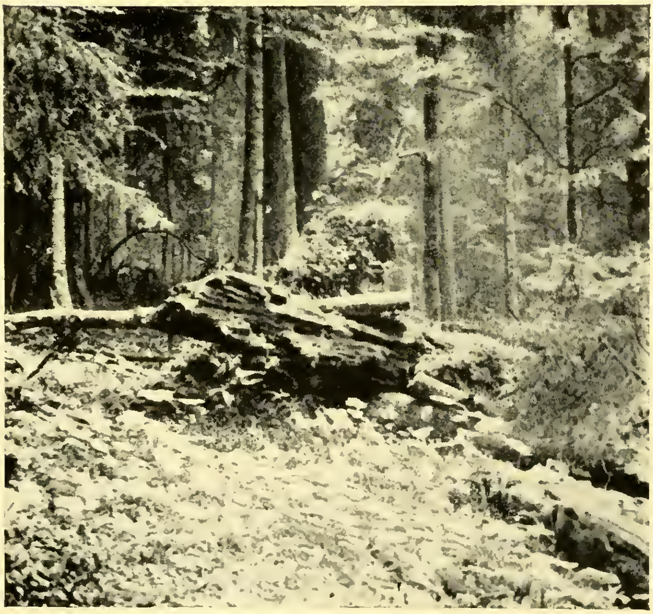
South America thus received the basic forms of her fauna from the northern mainland, by way of a bridge of land, and was enabled to retain them and transform them in a manner both prolific and peculiar, for this bridge sank beneath the sea about the middle of the Tertiary period. In proud isolation the continent breasted the ocean, and for long geological periods was protected from further invasion, so that the much older forms of the northern continent fell victims to younger competitors. When, about the middle of the Tertiary period, a wide isthmus came into being, and towards the end of the period the narrow bridge which we now call the Isthmus of Panama, the fauna of South America had already become so far established that the new migrations were unable to exterminate it.

Such migrations now occurred in both directions. From South America humming-birds, parrots, monkeys, butterflies and other insects wandered northwards, finding suitable conditions of life in

PLATE XIV



VIRGIN FOREST, CEYLON



VIRGIN FOREST, KUBANY, THE BÖHMERWALD

Mexico, then still tropical; indeed, many species made their way into the United States. But there were also migrants which followed the reverse direction. Above all, the hitherto absent Ungulates made their appearance in South America. Only the Tapir, the Antá, was already there; but it was probably now that the two little wild swine, the Peccaries, made their first appearance (Plate 27, Figs. 16 and 17). In the monastery I kept a young freshly-caught peccary in captivity. It was a Collared Peccary, or Catete. We opened the box in which it was imprisoned in an empty bath, thinking that the smooth walls would prevent it from escaping, but in a moment the little animal sprang lightly out of it. The Peccary has much longer legs than other wild swine; moreover, they are curiously perpendicular, and the animal has the appearance of a creature moving on springs. We thought there would now be a wild hunt, but scarcely was the little creature at liberty than he proved to be quite contented; he remained in our company, laid himself on his side, and let himself be scratched, grunting with satisfaction. He at once ate some bananas and behaved, on the whole, like a young dog. He was always glad of my company, and would gaze at me with his wonderfully beautiful eyes, soft as those of a doe, which distinguish the Peccary, greatly to his advantage, from his European relations. Only when anyone attempted to lift him up did he scream, and gnash his teeth in a threatening manner. Obviously he had no desire to be put into a dark box again.

Among the immigrants from the North whose remains are first found in the most recent geological strata are the deer (Cervidae) of all kinds and sizes which people the campos and forests of Brazil, including the little roebuck or Veado. The horse, too, of which great herds roamed the prairies of North America, made its way into the southern continent at an early period. It died out, however, before the coming of the Europeans; a scientific problem as yet unsolved, since the conditions of life remained unchanged and the horses introduced by the Spaniards profited by them to run wild and multiply exceedingly.

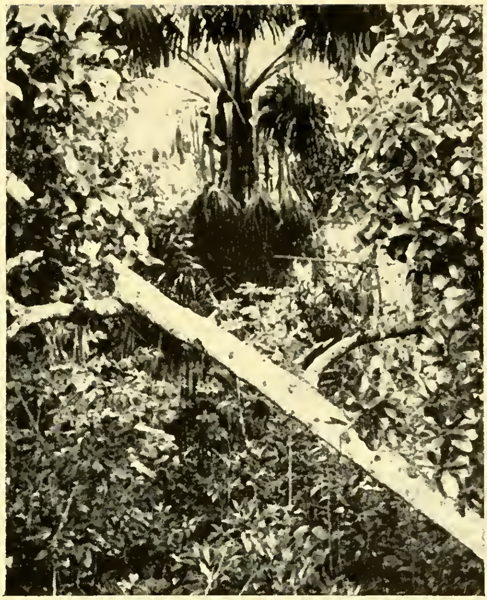
The Ungulates were followed by their enemies, the Carnivora; the two great cats, the Jaguar and the Puma, invaded South America. The Jaguar or Painted Ounce (Onça pintada) has become cautious, as a result of persecution by hunters and trappers. It is a magnificent animal, not much smaller than a tiger, and in any case larger than its cousin the Leopard, a bolder animal, which I often encountered in Ceylon. Like the Leopard, the Jaguar appears to have a liking for the flesh of dogs. The Puma is easily tamed, and of all the carnivora it is one of the fittest to become the graceful domestic companion of the animal-lover.

In addition to these two great cats, there is a whole series of smaller species, from the Ocelot, a small edition of the Jaguar, to the wild cat of the South, very like the wild cat of Europe. There is also a wolf in Brazil, but the great development of his molars shows that he is herbivorous as well as carnivorous. He is consequently harmless to sheep and cattle, and of course to man, his flesh diet consisting of Preyás and wildfowl. A smaller wild dog is of interest to zoologists because it represents a transitional form, approaching the martens. More common than either of these animals is the handsome Brazilian fox, which ravages the henroosts; but its valuable skin is an adequate indemnity.

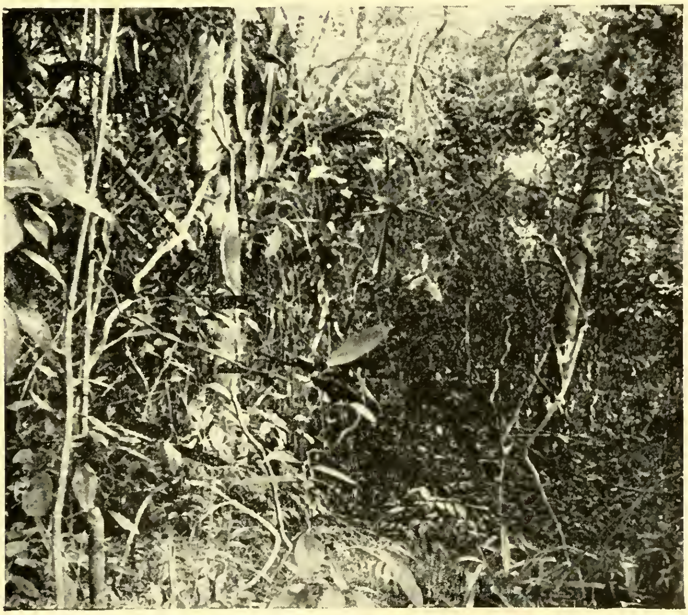
There is in Brazil a whole series of weasel-like carnivora, such as the blackish-brown Irára, with a yellow patch on the throat, and the Grison, with a light-grey back and a dark-grey belly. These animals, of course, are destructive to poultry, but may be tamed, and are among the favourite domestic animals of the Indians. Of greater importance is the Skunk, with his black coat, marked by two white stripes on the back (Plate 31). This animal, which wards off its assailants by the ejection of a stinking fluid, hunts the venomous snakes of the country, eating them, with the greatest complacency, from the tail upwards, while the reptile, with open jaws, desperately strikes at its enemy. The Cangambá, as the Brazilians call the Skunk, is quite unperturbed.

I must not omit to mention the large Brazilian Otter—much persecuted, unhappily, on account of its valuable skin—and the volatile Raccoon, and the Kinkajous, which, like so many of the animals of the Brazilian forests, have prehensile tails; they are gentle creatures, and the Indians welcome them as housemates. The Coatis have always been favourite pets, and in many courtyards one sees these creatures—they are red, and the size of a cat—leaping about at the end of a cord. With its pointed head and mobile, trunk-like nose the Coati slyly follows one's movements, and quick as lightning, when one comes within reach, runs up one's body, performing all sorts of antics. The Coati is quite fearless and thinks nothing of attacking a dog. Its behaviour is objectionable only if it manages to break loose; then it hastens into the nearest room, playful as a naughty child, tumbles everything about, and investigates it so thoroughly that it is soon in fragments. Nothing remains

VIRGIN FOREST, SERINGAL



BURITY-PALM IN SWAMP-FOREST



LIANAS IN VIRGIN FOREST, PERNAMBUCO

intact if the Coati is left to itself; but a gentleman who had for a long time kept a Coati assured me that there was one remedy. One must leave a brush in the room; the Coati would grasp this before anything else, and would brush its long tail with enthusiasm, becoming too absorbed in this occupation to think about further tricks.

On the whole, the Brazilian carnivora, like the Brazilian monkeys, have something lovable about them. The Indians of Brazil, who are a gentle people—as we shall see if we read the enthusiastic descriptions of Koch-Grünberg—and have always been great lovers of animals, domesticate all sorts of animals and birds as household pets. The explorer Martins was impressed by this love of animals, and he records that in the Indians' huts he saw as many tame monkeys as human beings.

"Every member of the family has, among these monkeys and handsomely-plumaged parrots, whose company is often increased by a sloth, captured alive, or a small anteater, his own favourite, with whom he often converses. The monosyllabic paterfamilias watches with silent amusement the droll movements of the menagerie. The garrulous mother and the elder children spend hours in teaching the parrots to speak. The children play in turn with whichever of the animals happens to come their way."

The Indian lives on intimate terms with Nature; for him there is no hard and fast dividing line between men and beasts. He knew nothing of the senseless destruction of animals, of killing for the sake of killing. If he wished to adorn himself with many-coloured feathers, he employed blunt arrows with little discs instead of arrow-heads, which only stunned the birds, so that he could take their feathers and let them fly again. It touched me to handle these arrows in the Parahyba museum.

So long as there were only Indians in Brazil, the fauna was preserved in all its wealth. Only with the coming of the white man was it otherwise. It was he who wrote the last chapter of the history of the Brazilian fauna, but in his hands it became a tragedy.

The tragedy of the human inhabitants of the country was worse than that of the animals. From masters they became slaves, and then hunted victims, and finally they had no refuge but the virgin forests of the interior. The doom of the animal world unfolded itself more slowly. In the beginning the as yet somewhat ineffective weapons at man's disposal could not cope with the endless wealth of animal life, ever renewed from the unexplored interior. The possibility of a true slaughter, of mass destruction, was first offered by the breechloader.

In Brazil the hunter is free to hunt; as yet there are no protective laws. The consequence is that the larger animals—and even the birds—are becoming rarer and rarer in the inhabited parts of the country. In the State of São Paulo the Italians, who have migrated thither in very large numbers, are accustomed to kill, if they can, every little bird they see, in order to put it in the pot. Fancelli reckons that in Italy the number of birds killed yearly must amount to one and a half millions. Moreover—and this is the greatest danger—industry is already beginning to lay hands upon the living jewels of the country. Industry, however, can be profitable only if its raw materials—in this case the birds and animals of Brazil—are delivered to it wholesale, for machinery offers it the possibility of making a whole series of objects at the same cost and with the same power, and so of offering goods at a price impossible to the craftsman.

For industry the feathers of the Brazilian birds are of the first importance. The magnificent Silver Heron or Egret, the Garça real of the Brazilians, bears on its back, at the mating-season, the beautiful plumes known to the trade as aigrettes, and the way in which this dazzling bird, an incomparable adornment of the landscape, has been persecuted all the world over, and in many places completely extirpated, is one of the most shocking tragedies of the animal world. In Venezuela alone, according to the official statistics, 1,538,738 Egrets were killed in the year 1898, while ten years later only 257,916 could be secured, so far had the work of extermination advanced. The gist of the matter, which should give everyone food for thought, is simply this: in order that a few men may make money, and women wear an ornament for a few years, some of the loveliest creatures on earth are being destroyed for all time.

Fashion is a capricious goddess, and although to-day it is not considered fashionable to trim hats with the skins of humming-birds, it may be so to-morrow. But these fascinating birds—and others as well, such as the Sahys and the Sanhaçus—may be used for other purposes besides trimming hats. Before the war I read that there was a shoemaker in Paris who was making ladies' shoes of humming-bird skins, two hundred skins being required for a single pair. According to Kaeflein, before the war 400,000 skins of humming-birds and 360,000 of other birds were imported into Europe from Brazil in a comparatively short space of time.

Fur animals do not play the same part in Brazil as in colder countries; nevertheless, the Brazilian Otter, or Lontra, is said to be nearly extinct as a result of reckless persecution. Workbaskets and bonbonnières are made of the armoured shell of the Armadillo, and one single business house in Hanover has sold more than a thousand of such baskets. Even the beautiful beetles and butterflies become objects of foreign trade. In the woods of Tijuca I saw with great satisfaction that placards had been posted forbidding the destruction or removal of natural objects. But apparently the splendid blue Morpho butterfly was not regarded as a natural object, for by the waterfall it was offered for sale to the public in boxes. In Rio too I saw in the shop-windows all sorts of ridiculous things which had been made out of the metallic blue wings of the Morpho.

If the original natural environment were still extant in all parts of Brazil, the danger of extirpation would not be great. But as we saw in the last chapter, the soil is being more and more widely cultivated, and at the same time the forest is being destroyed in regions which are unfitted for agricultural exploitation. The animals thereby lose their refuge and their breeding-places; their natural conditions of life are disturbed, and reckless persecution may easily make an end of them. Not only will Brazil have lost its loveliest jewels, but agriculture, as I have already pointed out, will have been deprived of its best auxiliaries.

For this reason every Brazilian who loves his country and has its future at heart should do his utmost to ensure the passing of protective laws. Mexico has taken measures to protect its green Quetzals, its antelopes, and its wild sheep, and has restored large areas to their natural state. On the motion of Dr. Leon Suarez the Pan-American scientific Congress of Lima (1924) resolved that the individual States should appoint commissions for the protection of natural life. The Argentine has just appointed such a commission for the protection of threatened animal and vegetable species, Professor Hugo Salomon of Buenos Aires being the president. It is high time that Brazil did the like; for now Matto Grosso, Goyaz and other parts of the interior are beginning to be cultivated, which hitherto, with their intact natural environment, were able to replenish the fauna which was progressively receding from the coastal belt. Once the interior is completely cleared it will be too late to save the animal life of Brazil.

The following measures are of prime importance:

1. The export of the skins and feathers of birds must be prohibited under penalties. These natural adornments are for Brazil, not for the hats of European women.

2. Close seasons for game animals must be established. The shooting and trapping of birds and the taking of nests should be forbidden, at least in the settled areas. Measures should be taken to protect the finest and most seriously threatened butterflies, particularly the Morphidae, and such animals as the Great Anteater, the Great Armadillo, the Otter, certain monkeys, and other species. It is also of importance to establish large natural sanctuaries—reservations and national parks—in which settlement and the use of firearms must be prohibited.

3. Measures must be considered and elaborated which will enable animals, and particularly birds, to find their natural conditions of life despite the increasing cultivation of the soil: it must also be ascertained which trees and bushes had best be left for nesting purposes, etc. The best plan would be to create a special department for the protection of wild birds and natural conditions.

Above all, the people of Brazil must be taught to love Nature, and to enrich their hearts and minds instead of filling their pockets and stomachs. I often came upon young men shooting birds "just for fun." What would be said of anyone who shattered the decorations of our churches and public buildings merely to pass the time? The most glorious temple of any country is its natural beauty; the birds and animals are its living ornaments, and he who does not respect them is robbing his own country, injuring its health, and undermining its future.

XI

NATURE AS AN ORGANISM

Brazil is a land of wonders, where birds fly like insects and insects like birds.

The Humming-birds, indeed (Plate 28, 2 to 5), which the Brazilians prettily call *Beijaflores*—that is, "flower-kissers"—are quite unlike other birds, if only by reason of their smallness; there are insects in Brazil which are larger. These enchanting little creatures appear in a flash, hover before a flower with wings that vibrate so rapidly that one can see them only as a shimmering radiance, while one hears not a rustle, but a hum like that of the propeller of a distant aeroplane. Suddenly, as by magic, the bird has disappeared. Next moment, however, it is hovering in front of another flower; it twists and turns by starts, still suspended in the air, and suddenly it is gone. No other birds but only the hawk-moths behave in such a fashion, and just as the latter uncoil a long trunk, which they plunge into the corolla of a flower in order to reach its nectaries, so the Humming-bird thrusts its long, curved bill into the flowers. It is, of course, looking less for honey than for the insects which are found in the depths of the flowers. Flowers and Humming-birds, however, belong together just as do flowers and insects, for the fertilization of various flowers is, as we shall see, effected by Humming-birds.

The Humming note of the almost incredibly rapid wing-beats of the Humming-birds has its counterpart in the insect world. Bumble-bees, carpenter-bees and wasps, magnificent forms of which are found in Brazil, hum during their flight; so does the Splendid Phanaeus, a great green dung-beetle with the shimmer of red on its wing-covers; and a yet louder hum is emitted by the Cicadas when their glassy wings bear their heavy bodies through the air. And the huge green grasshopper hums as it flies; an insect which I was always encountering in the cashew-forest of Pernambuco, and which really flies like a bird.

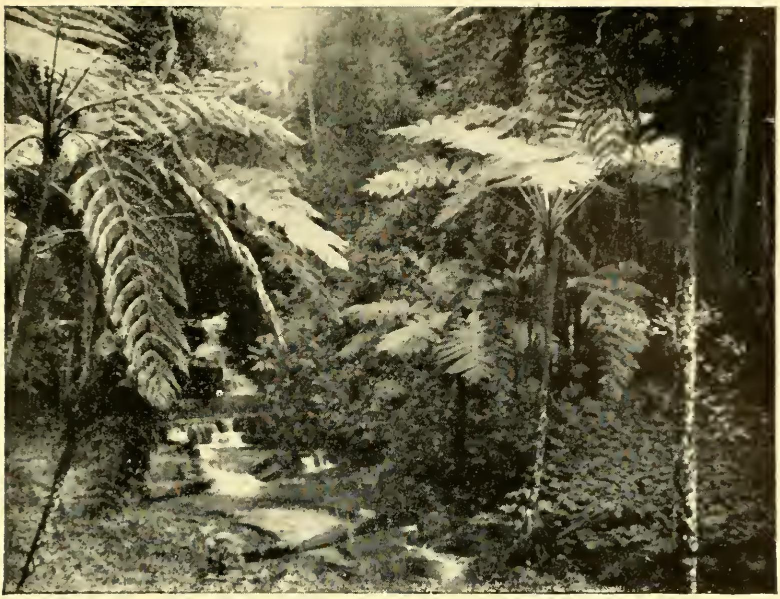
The flight of the great Caligo butterfly resembles the flight of certain birds—namely, the Goatsuckers. A bluish gleam flashes amidst the stems of the darkening forest. Now it comes nearer, flitting towards us on wings as large as a man's hand, on whose under side we see great eyes, like those of an owl.

In Brazil, then, the naturalist meets with something surprising at every step; every creature is unlike the creatures that he knows at home, and he is filled with reverence before such an inexhaustible wealth of forms. But he cannot be content with mere amazement; he longs to understand something of the wealth of species offered by the world about him. And he is struck, in the first place, by two things, and he perceives that they are mutually interdependent; on the one hand, the overwhelming powers of multiplication possessed by animals and plants alike, and on the other, the enormously varied conditions of life which this earth affords.

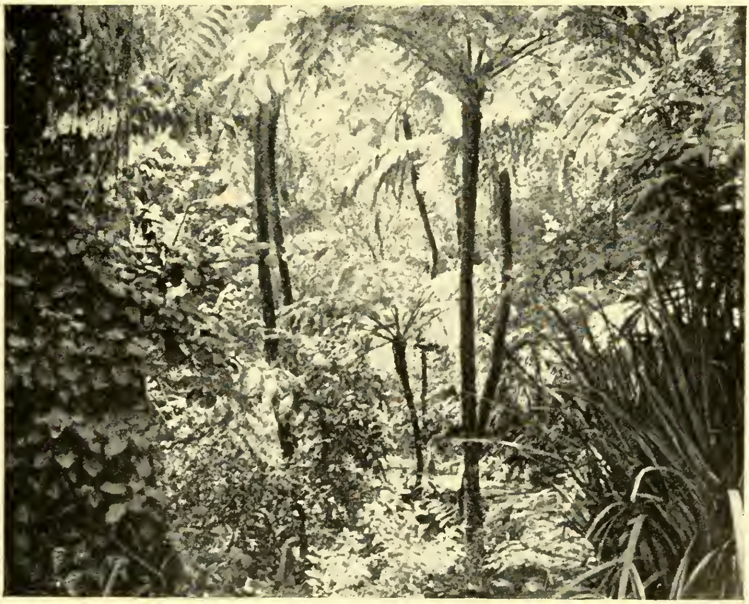
As a matter of fact, every plant, every animal, could by itself overpopulate the earth. In order to realize this, we have only to calculate the number of the descendants produced by any animal over a series of years—presuming, of course, that all survive and multiply. We shall perceive at once that from the very outset some counteracting factor is necessary. This factor is found in the living substance itself, which is a delicate and mutable mass, and cannot thrive equally in all situations, but must have its special conditions of life: namely, a certain temperature, humidity, nutriment, etc. But the conditions of life are not uniform in all parts of the earth, for the surface of our planet varies greatly in character: it has hot plains and cold mountain peaks, torrid and arctic zones, water and land, light and darkness, and all in innumerable gradations. Even though life is endowed with the urge to propagate itself incessantly, and to fill the whole earth, it must always adapt itself to these different conditions, and vary its form and its characters accordingly. And here we have the first reason for the multiplicity of forms existing in the animal and vegetable worlds.

Moreover: if we were set the task of filling a chest with stones so completely that the last and tiniest chink was filled up, we could accomplish it only by taking stones of different sizes, down to the finest particles of sand, with which to fill up the remaining spaces. All these stones would have to be most carefully fitted together. But even if this task of meticulous adjustment could be accomplished, what difficulties would arise if the stones all insisted on moving in prescribed orbits! Here human skill would be utterly baffled. With what reverence, then, should we regard Nature, by whom this problem has been solved!

Let us take any tract of woodland, a grassy plain, or a pond: we shall see that to every condition of life which such a fragment of Nature offers some living creature has adapted itself, and that



TREE-FERNS IN FOREST NEAR NOVA FRIBURGO (2,600 FEET ABOVE SEA-LEVEL)



TREE-FERNS IN CEYLON (AT 6,500 FEET) FOR COMPARISON

no possibility is left unexploited. And yet the plants are growing, and their seeds are laying claim to fresh soil; and the animals have the power of movement. The whole is like a piece of clockwork. Every living creature is a tiny wheel that turns in such a way that it does not hinder the rest, and yet it is so fitted into the whole that it cannot leap out of its framework. And it seems as though the clockmaker were continually testing his work, to discover whether there is not yet some little corner unused, whereupon he fits in yet another little wheel. The whole is so devised that it is self-regulating, and adapts itself to new modifications. All these are qualities lacking in our technical creations, for they are the qualities of life itself.

We call the individual creature which is capable of maintaining itself and regulating its activities an *organism.* An organism is a harmony of the parts within the idea of the whole. In Chapter VIII we saw how all the organs of the human body co-operate harmoniously to maintain the body. The same harmony exists in every animal, every plant, and in every department of Nature; and lastly, it exists in the whole living world of any country which possesses a special individuality. Such a country is Brazil.

No Brazilian animal lives entirely to itself; each is dependent on others; its relation to them is a necessary one, and cannot be filled by any other creature. We shall understand the individual animal only if we consider it in relation to others. And to learn what this is we must first of all consider its environment, its natural habitation.

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And here a comparison with human conditions will help to elucidate the matter. When a block of flats is let, a certain apartment is assigned to each family before it moves in; otherwise confusion and strife would ensue. Now the forest may be said to contain a number of different stories, and even these are divided among the birds according to a predetermined scheme. The birds do not simply build their nests in any indifferent position, as chance may direct; each bears within its breast the inexorable command to build in a certain situation, whether in a bush or a tree, or on the ground. If it cannot find the proper situation it does not without more ado put up with another, but either goes further, or does not nest at all. For the individual bird such compulsion is, of course, unpractical, but it is essential to the order of the whole.

On the floor of the forest, and particularly in the dense thickets of the *capoeira*, the little woodcock builds, the Inhambú, and in the grasses of the campos the brown birds which the Brazilians call quails and partridges, although they are related not to their European namesakes, but to the same Inhambú. The Sucurú (Plate 28) digs a hole in the ground, while the Jacamars, resplendent in bronze-green, with long bills, and resembling large humming-birds, make their long nesting-tunnels in the sloping river-banks, as do the kingfishers.

Even those birds that build in the branches do not choose any convenient position; one species prefers the lower boughs of the bushes, another builds at a medium height, and others nest in the tree-tops; the latter are either particularly sturdy birds, or birds of prey, for in the tree-tops the nests are for the most part exposed to the gaze of the feathered brigands who hover above the wood, and the smaller birds fear such enemies more than any others.

It is interesting to note that the structure of the tropical forest, which differs so greatly from that of a European wood, has induced quite different methods of building the nest. The scaffold-like structure of the tropical forest offers points of support everywhere, not only for epiphytes, but for the nests of birds, and the tangle of lianas running in all directions enables even heavy birds to leave the ground and fly from perch to perch, as though in a hen-roost. So the great game-birds of Brazil, the black Hokkos or Mutúm or Curassows, and the rather smaller Jacús, with their red wattles, nest in the trees, while our European game-birds nest on the ground. These Brazilian wildfowl prefer as a rule to keep off the ground, and the Jacús, if disturbed, do not at once fly off, but hop from bough to bough and from liana to liana, quickly and silently disappearing from sight.

Most of the smaller European birds build their nests in trees or bushes, in the crotches of boughs, or where a branch divides into twigs, and they prefer trees and bushes of no great height, since bushes are thicker and twigs more numerous near the ground.

In the tropics, where the foliage is more open, it is not so easy to conceal a nest in a bush or thicket. Even when I was in Ceylon it struck me that there more birds nest in holes in the trees than is the case in Europe. With its larger masses of timber, the tropical forest affords more numerous opportunities for this method of nesting; the more frequent ramification of the trees into boughs, which often turn perpendicularly upwards, is partly responsible; in the angles of the boughs, which are exposed to the drip of rain, the wood often rots, leaving a hollow. Thus, in Brazil the birds that nest in holes do not depend exclusively on the woodpecker, that born carpenter, who in Europe works for mice, doves and owls. The parrots, with their strong beaks, can quickly excavate and enlarge a rotten spot on a bough or tree trunk. They too nest in hollow trees, until we come to the Monk Parroquet or Lory of the Southern Argentine, which builds a great nest of brushwood, like the birds of which I am about to speak.

As regards the nest-building birds of Brazil, it is a striking fact that many species appear to take no pains to conceal their nests. In a tropical forest this indeed is not absolutely disastrous, for the trees display so many foreign bodies, what with epiphytes, and the nests of ants and termites and other insects, that a nest resting on an exposed bough is not so conspicuous as it would be in Europe. Moreover, many of the Brazilian birds build covered or enclosed nests, in which the eggs and nestlings are concealed from sight. They are egg-shaped or pouch-like, and have the opening at one side. Most of the Tyrannidae build such nests, and so do the Bemtevis. The little Teque teque even builds a gabled roof over the entrance-hole, so that the nest has an artificial appearance. Several of the tree-thrushes too build closed nests, and so does the Sebito (Plate 28), which I was able to observe at work.

At the same time, the birds are careful to avoid easily accessible positions for their nests. I often found the nest of the brown and white wagtail or Lavandeiras, of which I have often spoken; a carelessly-made, almost spherical nest, built in a bush rising from the water; it was visible a long way off, but was inaccessible to robbers. When the young birds were first taken abroad the parent birds were very much on the alert, and flew excitedly hither and thither, uttering a lively *pleck*, *pleck* if I approached. The starlings—the Checheous, for example—hang their bottle-shaped nests from branches of riverside trees projecting far over the water, so that frequently they almost touch the surface. The black Japús hang their long wallet from the extreme tip of a palm-leaf, and often build in whole colonies; a tree full of such nests is an astonishing sight. The Japús are sturdy birds, almost as large as crows; for them combination spells security, all taking the part of each. Of the Anums it is even said that several pairs of these black cuckoos will occupy a single nest, sitting on their eggs in peaceful juxtaposition.

I saw such a case with my own eyes, the owners of the nest being "Bundle-nesters." These birds, which the Brazilians call *Ferreiros*

(Smiths) because their "song" sounds like the noise made by a knife-grinder, were described in Chapter VII as among the characteristic birds of the Sertão. They are, however, common throughout Brazil (Plates 21 and 28). I often saw the species which is found in northern Brazil, and which constructs enormous bundles of brushwood, at work upon its nest. (This is the bird which the Indians call Turucuhé.) First a twig is laid in the crotch of a bough; and the next few twigs are carefully fitted together. If one falls to the ground the bird utters its call, *trip, trip, trip, trip* in rapid crescendo, retrieves the twig, and replaces it among the others. Finally a great bundle of brushwood, often as long as a man's body, hangs from the bough, pulling this down with its weight (Plate 21). I have known two pairs of birds build such a nest in complete agreement. There were two separate entrances; one pair slipped into the upper part of the nest, while the other entered a little lower down. Once, when I picked such a nest to pieces, which I was able to do without difficulty, except that I had to beware of thorns, I found three nests, one over another; they were lined with poultry-feathers, and a number of cast snake-skins were woven into the structure.

These little brown birds have thus contrived a nest which is a fortress impregnable to the attacks of birds and beasts of prey; and its security is increased by the fact that a new nest is built every year, while the old nest is left hanging, and holds together for years, so that one never knows which nest is inhabited. These great bundles give the landscape of north-eastern Brazil, and especially that of the Sertão, a definite and most individual character.

Another nest which is visible from a great distance is built by the Potter-bird, João de barro or "Clay Johnny." This coffee-coloured bird, of the size of a thrush, first attracted my attention at Petropolis. He had built his clay pot, with the rounded bottom uppermost, on a bare, horizontal bough. The side entrance led into a vestibule, which was divided from the nest proper by a low partition. This nest was visible from a considerable distance; the birds were flying to and from it quite openly, and now and again the cock emitted his prolonged, wooden-sounding trill. In the park of Palermo in Buenos Aires the potter-bird is a conspicuous inhabitant, hopping all over the lawns.

For nesting-material the Brazilian birds have an ampler choice of material than is available in Europe. Many palm-leaves, when they are withered, split into long fibres, and these, which are exploited by our human industries also, yield a strong textile material. I once saw a Sebito pull these fibres from a palm-tree while on the wing, and fly with them to its nest. For lining the nests the finest wadding is available; the birds have only to pull it from the ripe capsules of the cotton-plant. I once saw a Humming-bird adopt an even easier method, pulling the cotton for his nest—which was no bigger than a walnut—from the nest of a Wagtail, hovering motionless before it with humming wings.

There are several Brazilian birds which even seek refuge with man. The Brazilian Canary rears its brood under the tiles of the roof, as our sparrows do in Europe, and swallows too build their nests in stables and vestibules. These nests, however, are not built of clay, but are woven of a sort of felt; they are spherical in form, and have a long bottle-neck entrance underneath. The Vira bosta (literally, cow-dung turner) lays its eggs, like our cuckoo, in the nests of other birds. It is a black bird, fond of frequenting cattle and picking the ticks from their backs.

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Just as the dwelling is by no means a matter of chance, so with the domicile; every locality has its special inhabitant, which is compelled to remain there by the fact that its body is so constructed that it cannot be comfortable elsewhere. Thus, lizards prefer the sunlight, and toads the shade; and similarly there are sun- and shade-loving insects; and some which prefer the upper surfaces of leaves, while others prefer the under side, or the boughs. Monkeys, sloths, raccoons and opossums live in the trees; deer, foxes, pumas and agoutis on the ground. The forest and the plain have each their own forms of life, and very often quite closely related species are found in each; it is thus with many of the rodents, and the larger and smaller deer, and the carnivora, and the gallinaceous birds, and other species. The mountains, too, have a different fauna at different altitudes.

As in a school whose classrooms are not large enough to contain all the pupils different classes and different subjects may be taught in succession at different hours of the day, so birds and animals and insects, in a state of Nature, may apportion between them the hours of the day. There are creatures which seek their food by day: as do most of the birds, the monkeys, and the squirrels; and others which profit by the hours of the night, as do the majority of the mammals, the owls, and the goatsuckers. The venomous snakes do not go abroad until it is dark, since their victims—for the most part rodents—do not come out of hiding until the night has fallen; whereas the non-venomous snakes hunt their prey—frogs and lizards—in the daytime. The birds are most lively and conspicuous in the morning; in the heat of noon many of the insects become active; the lizards are most vivacious when the sun is at its hottest, and the Jacarés too, like all the crocodiles, first come ashore when they can bask in the vertical rays of the sun. For these creatures, moreover, the heat of noon is a protection against their arch-enemy man, who at this hour is reluctant to leave the shelter of his house.

From the windy heights to the sub-soil, every level has its inhabitants. Far overhead the Brazilian vultures, the Urubús, hover all day, scanning the widest possible area for signs of carrion. Below them is the level of the swallows, hunting the insects on which they live; lower still the Humming-birds flit round the flowering shrubs. All these are birds which pass the whole day without once alighting on the ground, save for exceptional reasons. Of the loveliest Brazilian butterflies, the metallic-blue Morphidae, one species, the Menelaus, flies low and quickly along the green paths of the Tijuca forest; another, the Anaxibia, flies at a height of thirty feet, floating along in majestic tranquillity, for at that height enemies are rare.

Even the depths of the soil are, so to speak, divided into stories. Immediately under the surface crawl the millipedes and centipedes, which live on the mouldering leaves that lie on the ground. Beneath them are the burrows of the mole-crickets, which graze upon the roots of plants, as do the grubs of various beetles. The "two-headed snakes," which are really lizards, and of which I shall speak in Chapter XIX, likewise burrow into the soil. They are hunted by the black, red and yellow coral-snakes. There are no moles in Brazil, so the armadillos have to attend to the business of keeping down the grubs.

Nature, then, acts like a wise agriculturalist, who so distributes his fields among his workers that each can exploit his allotted area without disturbing the others. Even the most out-of-the-way spots are not forgotten. We have already seen that in the water which the Bromelias retain between their leaf-insertions a whole series of aquatic creatures contrives to exist. Even temporary accumulations of water are utilized. Lüderwaldt found in the water contained by the still unfolded leaves of the Heliconia a large, light-brown slug and several small water-beetles. When the leaves unfold the water is spilt, and the inhabitants must retire to other and younger leaves.

How many creatures find a safe refuge in the nest of the Leaf-cutting Ant, including some that have no dealings of any kind with the ants! I once found, in such a nest, three Kalangu lizards, three narrow-mouthed frogs, one other frog, various beetles, and one coral snake of a non-venomous species. In Ceylon I always found, in the air-shafts of the termitaries, the black scorpions of the country, large as crayfish, and millipedes; and if I searched several termitaries I could always be sure of finding the Spectacled Snake.

Even the voracity of the Rosy Caterpillar, which turns the contents of the cotton-pod into a black pulp, provides many living creatures with a lodging. Three small beetles make their home there; the larva of a fly feeds on the pasty contents, full of the droppings of the caterpillar, and also the caterpillars of another species of moth. These creatures may be of service to the planter, inasmuch as they eat the food of the Rosy Caterpillar, which is obliged to leave the pod for another, and on the way may be seized by one of its enemies. The little black Cotton-bug, which likewise makes its appearance in the pods of the cotton-plant, sucks the sap of even the healthy pods, and multiplies to such an extent that the cotton-field emits a far-reaching and most disagreeable odour of bugs.

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The relationships of which I have just been speaking affect not only the problem of domicile, for in them the food problem is an essential factor. Now the problem of nourishment must not be ignored in a chapter dealing with "Nature as an Organism," for almost more plainly than by its distribution in space, the living creature shows, by the choice of nourishment, that it is subject to the influence of a great whole. We can understand that the food supply must be most carefully apportioned. Otherwise all creatures would fall upon the best food, or the easiest to reach, or would be guided by mere chance. But then one area would soon be eaten bare, and later comers, or offspring subsequently hatched from eggs, would go hungry, while elsewhere food would be piling itself up untouched.

Therefore the Morpho butterflies lay their eggs, according to their species, either on the forest trees or on the climbing plants that twine around them. Where the passion-flower climbs upwards at the edge of the forest the black, red and yellow Heliconidae appear; the great Caligo, with the owl's eyes on the under side of its wings, makes for the banana; and the *Brassolis astyra*, a handsome dark butterfly with yellow crossbands, for the coconut-palm. The Thoas, a great black and yellow Swallowtail, breeds on the lemon-trees, and the brown and red, gently fluttering Danaïd on the poisonous Asclepiadiae, to which family the broad-leaved Wax-plant belongs.

For even the poisonous plants must be utilized, and they have their lovers, whose digestive systems are so devised as to tolerate their poison. Similarly, the venomous snakes are devoured by the handsome black Mussurana, a harmless snake, and the Skunk kills the largest rattlesnake without heeding its fangs.

What I have said of the butterflies is true likewise of the beetles, grasshoppers and bugs. If an insect is adapted to feed on a certain plant, it will inevitably find its way to its pasture, since it is only on this plant that the mother insect will lay the egg from which the insect is developed. The insects which grow to maturity on plants of other species cannot deprive them of their food, since for them it is not food at all. There are, of course, "polyphagous" creatures, which can live on several kinds of plants. We might explain their evolution as follows: At first each plant would have supported *one* species of insect. After repeated experiment it would have proved that this insect did not exploit its plant to the full, and yet that what was left would not by itself be enough for another insect, whereas it would suffice if eaten with what was left of other plants. Thus insects might be intercalated which would have to feed upon three or four kinds of plants, and then insects which ate whole groups or families of plants, and finally insects which went everywhere and ate whatever there was to be eaten.

At the same time, we must remember that no species of plant can be entirely devoured. So much of it must always be left that it can still flower and bring forth its fruit, in order to spring up anew in the following year, otherwise the insects of the next generation would find nothing to eat. And for this reason the relation of the insect to the plant must be a more subtle relation. The number of eggs laid must be exactly proportioned to the amount of nourishment provided. Small plants which grow singly in the midst of other plants receive always only a few eggs. The butterfly flies on until it comes to the next plant of this species, and again lays two or three eggs, and so forth. Trees, on the other hand, which contain a surplus of food in their massive crowns, may be favoured with all the eggs of the insect whose larvae are adapted to live on them. The Brazilian butterflies, however, are often very large, and so are their caterpillars. In order that these caterpillars, when feeding in such

PETROPOLIS. IN THE FOREGROUND, GERMAN SCHOOL-CHILDREN

ARAUCARIAS IN FRONT OF THE YPIRANGA MUSEUM, SÃO PAULO

numbers, may not at once be perceived by their enemies, many of them feed only by night. By day they all assemble and take refuge, packed together, in a rolled-up leaf. This, for example, is how the caterpillars of the Brassolis, which feed on the coconut-palm, pass the day. The caterpillars of the blue Morpho Hercules, on the other hand, crawl down the trunk of their tree, or down the nearest liana, and huddle together at the foot of the stem. The smooth, dark, moist mass of caterpillars constitutes a repulsive-looking object, unless indeed it is mistaken for a mere outgrowth of the tree-trunk.

Not only the insects, of course, must perforce adapt themselves to the ordered scheme of Nature, but also slugs, snails, worms, fishes, birds and mammals. And not only the leaves of the plants, but the flowers and fruits are edible, and for all of them the appropriate creatures are appointed. We can tell the diet of the birds from the form of the beak; the grain-eaters have short, strong beaks, which enable them to crack the husks of the grain; the insect-eaters have long, slender bills, which can extract a caterpillar from the crevices in the bark of a tree as well as a pair of tweezers, or snap up flies when the bird is on the wing. The powerful beak of the parrots, of which not only the lower but also the upper mandible is movable, helps the bird not merely to climb, but also to crack the hardest nutshells, and a rasp-like roughening of the beak prevents the shell from slipping between the mandibles. In the Macaws or Araras the root of the beak is reinforced, so that they are able to crush even the stone-hard shells of various palm-nuts.

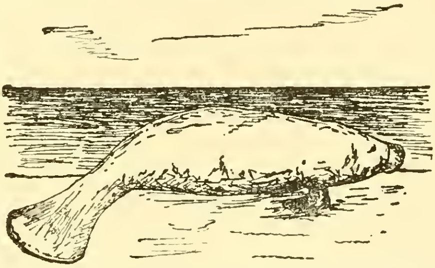

FIG. 12.—Manatee or Peixe boi. Natural length, 10 to 16 feet.

Even the aquatic plants have their devotees. Since the Hippopotamus is not found in the great Brazilian rivers, its place is taken by a peculiar creature which seems a cross between a sea-lion and a whale, and which grazes on the aquatic plants with such assiduity that its stomach and intestines are constantly full of them. This great animal has a wide horizontal tail, and two flippers in the place of arms, and since its head, when it thrusts it out of the water, bears a remote resemblance to that of a hornless cow, the Brazilians call this aquatic animal the "Ox-fish," Peixe boi; English sailors have called it the sea-cow; it is better known as the Manatee or Dugong. There is also a real fish, the Tambaqui, which grazes on the Eichhornia, and even eats the flowers of the Victoria regia.

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We have hitherto regarded this ordered scheme of Nature only as it benefits the eaters. But since Nature is a harmonious whole, no animal and no plant is especially favoured, but each is so conditioned as is best for the continuance of its species. And as the animals, birds and insects need the plants, that they may live on them, so conversely the plants need the animals, birds and insects. For a plant, if it had no creatures to eat it, would multiply unchecked, and would finally be stifled by the very excess of its own shoots or saplings. In a sense the insects are gardeners, who prune the plants to prevent them from running to leaves. And inasmuch as they prevent every plant from spreading too vigorously, they keep it in its proper place, and the other species of plants are able to grow beside it.

Provision, however, is made to ensure that this pruning is kept within the proper limits. The insects themselves must not multiply so excessively as to devour these food-plants entirely, for then they would perish for want of the only form of nourishment which agrees with them. Nature achieves this regulation by ensuring that every insect, and indeed every animal, has it enemies, which keep it within the necessary bounds by devouring the surplus of the race. But in order that things may not be left to chance, when great numbers of insects would be swept away, while others would be hardly touched, the hunters too have been specialized, and each species has its enemies, who are precisely adapted to its special peculiarities.

Thus, there are birds which catch creeping insects, and others which snap up flying insects. If in Europe the early summer is cold and rainy, most of the young swallows and fly-catchers perish, for the insects do not fly in cold rainy weather, and we then regret that these delightful little birds cannot eat worms and caterpillars instead. But once more we must take the broad view, that the flying insects must have their enemies, and that these, under normal circumstances, have more than enough to eat.

In Brazil, where there is no winter, the insects are able to fly all the year through, and so we find in Brazil an unusual number of birds which feed principally or even exclusively on insects captured on the wing. Such birds will sit motionless on an elevated perch, or perhaps a post, from which they can see in all directions; then suddenly they take the air, catch a passing insect, and return to their perch with a graceful curving flight. Among such birds are the "Widows," black birds with white heads, the Pipridae, most of which have in their plumage a good deal of black, which emphasizes the brilliance of the red, yellow or white head, and above all the Tyrants, relatives of the Bemtevis, the Siriris, and the pretty "Scissors-birds" with the long forked tails. The Tyrants, in their flight and behaviour, are very like the Bee-eaters of Asia and Africa, though the blue-green and yellow plumage of the latter is more brilliantly coloured. They devote themselves more especially to the chase of sting-bearing insects.

Birds follow the insects into their most secret hiding-places. The tiny beetles which cling to the stamens of flowers and feed on honey are captured by the Humming-birds, whose small size and long bills enable them to draw the insects from their hiding-places, while their extremely adroit flight enables them to hover motionless before a flower. This ability to hover is most necessary, for the flower-stalks, to say nothing of the stamens, are too delicate to bear the weight of the bird, and many flowers are accessible only from the air. I have often been struck by the great numbers of insects living in tropical flowers; in particular whole flocks of the short-winged beetles may be seen adhering to the stamens.

Even the beetles and grubs which burrow in wood, and are apparently quite secure from the dangers of the outer world, are dragged out of their dark retreats. How comprehensive is the adaptation of the Woodpecker to its task! The legs are set well back, so that the whole body can follow the stroke of the powerful beak; and when the dark tunnels are laid open the long, protrusible, and excessively sensitive tongue, with its needle-like point, transfixes the insects, or catches them with its asperities. There are many fine woodpeckers in Brazil, resplendent in black, white and red, or in yellow and green (Plate 28).

The larvae of gnats and mosquitoes concealed in the ooze of ponds and rivers are eaten by the ducks, whose broad, fringed bills constitute a sieve which lets the ooze escape and retains the larvae. The appetite of these voracious birds is in proportion to the amount of food at their disposal.

In the tropics the Ant family is most abundantly represented, and many a naturalist has been impressed by the fact that under stones which in Europe would conceal Carabidae, one is surprised almost always to find ants. In Brazil, therefore, a whole series of birds have accustomed themselves to living on ants. The Bemtevi and the "Scissors-bird," when the "Içaṡ"—that is, the females of the Driver Ant or Sauva—are scrambling all over the paths, fill their crops with these formidable insects, and prevent the formation of many a fresh nest of the mischievous Leafcutting Ants. But there is also in Brazil a whole group of specialized "Ant-birds," containing many species, which assist the Anteaters—mammals which have adapted themselves to the same diet—to prevent these redoubtable insects from gaining the upper hand. Of some of these birds, such as the Fire-eye (Plate 28, Fig. 23), whose red eye glitters most uncannily in its setting of black plumage, Dr. Snethlage has observed that they seek out the great processions of the Driver Ants, not in order to eat the ants themselves, but rather to devour the insects which these savage marauders (of which I shall say something later) drive before them. For days on end these birds follow the Drivers, looking down on them from some branch near the ground, and immediately seizing all the grasshoppers and beetles that hurry to one side, thinking themselves already saved.

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But even the hunters of the insects must themselves be under control, and so they too are pursued by other creatures, which limit their multiplication. The insect-eating birds are eaten by birds and beasts of prey, and the rodents, and other small mammals also, have similar enemies. Thus one wheel of the great mechanism gears into another, and there are whole trains of such interdependent wheels. For example, the shooting of birds of prey may result in the destruction of the cotton-crop. As I have already explained, the cotton-pods are destroyed by the Rosy Caterpillar. This would multiply far less readily were there plenty of the small birds known as Sebitos in the neighbourhood. Now, if the birds of prey are destroyed the Blue Ravens and Hudús are rid of their most determined enemies. These birds, with their blue, white and black, or blue, red, black and green plumage, are among the loveliest of birds, but they have, like our jays, the regrettable habit of devouring the eggs and nestlings of smaller birds, and where they are too numerous they may prevent the propagation of a small bird like the Sebito. For the sake of the smaller birds there must be large birds of prey; so that any disturbance of the equilibrium of Nature may make itself felt in a wholly unexpected direction.

From such considerations it indubitably follows that birds and beasts of prey are *necessary.* They regulate the proper mutual proportions of the individual species; if they were absent, now one and now another species of predatory bird or animal would multiply so profusely that it would become unduly destructive, or it might even finally perish from lack of food or disease. Now, since man himself is a beast of prey, he seeks to drive his competitors away from the banquet of life. If he himself wants to eat the Pacas and Preyás, he tries to exterminate the foxes and birds of prey which have an appetite for the same food. But how can we hope that the harmony of Nature will be preserved if man himself plays the part of the beasts of prey?

In any case, the most requisite measure is to ensure that close seasons are established for wild birds and animals. For the fox can never exterminate the creatures which are his prey, since his strength and cunning are so proportioned with regard to the swiftness of these rodents, and their ability to conceal themselves, that an equilibrium is maintained. Man, with his superior intelligence and his long-range weapons, can and will, if he does not restrain himself, exterminate all these creatures; moreover, by transforming the landscape he deprives them of their natural environment.

There is also a second consideration. Man shoots his game as it offers itself to his fowling-piece or rifle; swift and slow, all are within reach of his gun. The beasts of prey, on the other hand, find it difficult to catch the creatures which they hunt if these are speedy and full of life. Their victims are mostly the weaker individuals, and if an animal is sick or wounded they are certain to catch it. We know that our dogs can always tell by the scent if one of their own kind, or even if their master, is ill; and we know that when a bitch is on heat dogs will come running in from such a distance that we cannot imagine how they can have learned of her condition. In Brazil, as in Germany, I have often seen carnivora quite close to their usual prey, yet neither animal seemed to take any notice of the other; for both were healthy and on the alert, and a chase would have been unavailing. But if a beast of prey discovers the trail of a sick animal it knows at once that it will be able to secure it, and follows the trail until it has seized its victim.

For this reason the herds of cattle on the steppes expel all sick and aged animals from their community, and other animals too hate their sick fellows; they will bite them and drive them away without compunction. To us such behaviour seems cruel, but it is merely a measure of self-protection. If a sick animal were retained in the herd the latter would constantly be followed by beasts of prey, so that the rest would never be out of danger.

By always seizing upon the sick and weakly animals, the carnivora protect the rest from infection and degeneration. The weaker animals are devoured before they are mature, so that they cannot bring forth young to inherit their weakly bodies. The carnivora are, amongst other things, the sanitary police of Nature; they are, so to speak, her physicians.

As in Europe, so in America, one hears of cases in which the extermination of beasts of prey has been productive not of good but of mischievous results. In Florida the destruction of the alligators was followed by an increase of other pests, such as the venomous moccasin snakes; in Louisiana the musk-rats multiplied exceedingly, and did much damage to crops by extensive burrowing. In India various villages have protested against the shooting of the tigers, because these feed chiefly on wild swine, which, in the absence of their enemies, multiply so rapidly and become so audacious that the villagers may lose their whole harvest. These tigers, however, do not attack man.

In a state of Nature the distinction between useful and noxious animals does not exist. Every animal, whether hunter or quarry, is in its place in the great mechanism, and a necessary part of the whole. This really goes without saying, for however far we go back in the world's history, wherever we find life there we shall find beasts of prey. They have always existed, and nevertheless animal life has been abundant and flourishing. The human physician confines his attentions to the sick; Nature applies herself to keeping the healthy in health; and if we compare the wholesome world of the animals with the world of man and his domestic creatures—plagued with all sorts of illnesses, with obesity, and weak sight, and other infirmities—we shall form a different idea of the apparent cruelty of Nature, and declare that she is the better and more merciful physician.

Nothing, therefore, could be more foolish than to play the judge, and to attempt to sentence the carnivora to death on account of their "bloodthirsty nature." It is not their fault that their intestines are adapted only to a flesh diet, and any reproach is really directed not against them, but against the Power which made them as they are.

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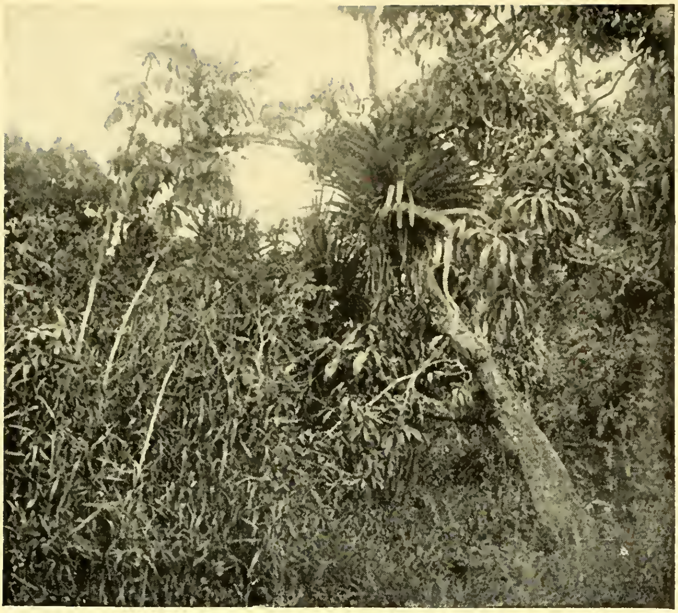
If now, having recognized the *modus operandi* of Nature, we leave the virgin forest of Alto da Serra in São Paulo, and gaze across the grassy levels, rippling in the wind, where the sky-blue Sword-lilies and the white Polygala stand out in their delicate loveliness (Plate 11), the whole beautiful picture will seem transparent as a painting on glass, and we shall see behind it the work of a controlling hand. The insects which float over the flower-enamelled plain will now seem to us like gardeners, each of which applies the pruning-knife to its special plant, so that it shall not grow too rankly; and the birds, operating from the thickets and the edge of the forest, control this activity, removing those gardeners who have become superfluous, and the hawks circling in the breeze regulate the numbers of the birds.

This fragment of Nature, like every other, offers us an example of a sensitively organized economy. Here that which is in the depths of the soil rises in time to people the winds; ever more delicate and active forms of life are built up from the lumpish earth. From the earth the plants derive their materials; in their leaves, with the help of the sunlight, they draw strength from the water taken from the soil and the carbon dioxide of the air, as the first step in building up the substance of the living creature. So the grasses of the plain elaborate in themselves, from the lifeless materials of the earth and its airy envelope, the growing, organized substance, the basis of all life, without which the animal world could not exist. The work of the plants is continued by the smaller creatures: snails, beetles, grasshoppers and caterpillars live in the grass and build up their bodies with the help of its green tissues. They pass on what they have elaborated to the larger insects, and to frogs, lizards, and birds; the living substance becomes increasingly full of life, and the living creatures more and more independent of the soil. But even of the higher orders of animals many return to this first form of nourishment, for the grass thrives so luxuriantly that it is able to nourish even the larger forms of life; indeed, it is so organized that it merely grows thicker if shorn, as our own lawns will teach us. Animals which live on the stiff, sharp-edged grasses must have strong teeth with sharp-cutting edges; but the Rodents and Ungulates which live on grass are of course endowed with such teeth. And to extract the nutritive matter from grass-seeds a masticating stomach is necessary, a gizzard whose muscular walls are able to grind the seed, such as the gallinaceous birds of the campos possess.

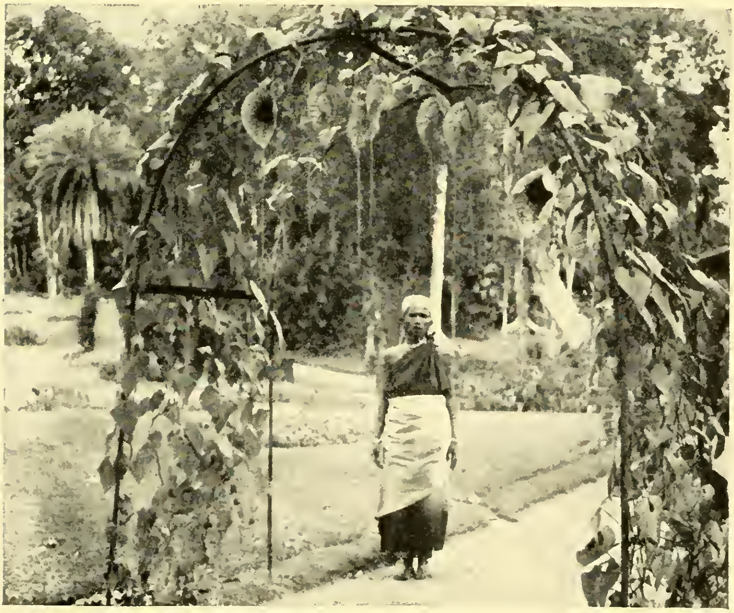
The grass, which without trunk or boughs has to withstand the force of the wind that scours across the open plains, must perforce elaborate effective reinforcing substances; consequently it contains many indigestible components, and must be eaten in large quantities if it is to suffice the needs of an animal, especially when it is dried and withered by the sun. For this reason the Bovidae and other ruminants are provided with several stomachs, which nourish the body in different ways; while the Rodents retain their food for an unusually long time, partly in a stomach which has several compartments, and partly in an enormous caecum, which in the hare is longer than the animal's body. The nature of this diet entails an abundant excretion of indigestible material, so that the soil is constantly manured, which favours the growth of the grass. A striking lesson as to the difference between the harmonious activities of Nature and the one-sided activity of man is afforded by the fact that for thousands of years the soil of the steppes—for example, the steppes of the Ukraine—retained the greatest fertility. Only when man began to cultivate the black soil did its productiveness diminish. Similarly, in the State of São Paulo the coffee-planters exploited the red soil, the *terra roxa*, prepared by Nature. The cultivation of coffee exhausted it in a few years, and the planters are continually obliged to take fresh virgin soil into cultivation.

The dung which the animals of the steppes provide in such abundance enables certain other creatures to make a living. Dung-beetles of all kinds are typical inhabitants of the grassy plains. In Nature everything is utilized and drawn once more into the cycle of life. Bodies whose life has departed build up the living bodies of burying-beetles and vultures. Even the food which is still passing through the intestine of an animal does not escape attention, and since, as is evident, a good many digestible substances are excreted without being utilized, parasites, in the shape of intestinal worms, find their way into the animal's body, transforming these substances too into living substance. Just as in human factories efforts are made to utilize even the waste products, so no stage of the long way from the earth to the living animal, and back again, is overlooked. Everywhere life adapts itself, and nowhere on its upward or downward journey is the evolving substance unexploited.

But if one animal is set over another, what of those that form



BROMELIAS IN PERNAMBUCO



ARISTOLOCHIA GIGANTEA IN THE BOTANICAL GARDENS OF PERADENIYA, CEYLON

the final link of this chain? Must not their multiplication too be controlled with all the rest, and in this case are not the controlling enemies lacking? Well, in this case Nature has employed the other method at her disposal: she has diminished the animal's power of multiplication. The elephant fears nothing, and therefore multiplies but slowly: the cow elephant carries her calf for twenty-two months, and bears young only once in every two years.

We see, then, that Nature can dispose of two methods of limiting the numbers of an animal which seems likely to overtake the rest and so disturb the equilibrium. She can increase the danger of its destruction, or decrease its powers of multiplication. If we survey the animal kingdom we see these two possibilities in every imaginable degree of combination. The result, however, in the case of every animal or vegetable species, is always this equation: The danger of destruction stands in such a ratio to the coefficient of multiplication that the species retains its place in the general ensemble.

An animal diminishes the dangers of the destruction which threatens it by holding its enemies at bay by means of mere strength, or the use of special weapons, or by escaping them by the speed of its flight, or by discovering a secure place of refuge, or by concealing itself so effectively, by means of its colour and form, that it cannot readily be detected. The large birds of prey produce only one or two young at a time. But who threatens them, who can reach their brood, safe in the highest tree-tops or on inaccessible precipices? Above the shore of Olinda the black vultures float in the air all day; but their breeding-place is hundreds of miles inland. But what is a distance of a few hundred miles to these proud navigators? With a favouring wind it is soon covered, without even a flap of the wings!

The small birds, as a general thing, lay five eggs, for they have many enemies to fear, and those that nest on the ground lay even more. Of the mammals, the Pacas, Capyvaras, Preyás, and particularly the mice, multiply exceedingly. But they are the chief prey of most of the carnivorous birds and animals, and the much-persecuted rodents could not make up for their constant losses save by almost incredible fertility.

The fish multiply even more vigorously. Many species produce more than 100,000 eggs. In the water, however, the battle for existence is waged in its most inexorable form. Almost every fish hunts and swallows smaller fish; the eggs and young fry suffer terrible losses; larger fish which find their way into a shoal of fry fill themselves to repletion, for which reason the young fish prefer to swim in shallow water, where the large predatory fish cannot get at them.

Even in the water the economy of Nature begins with the green plants. It is not, however, the larger aquatic plants which constitute the first form of nourishment, but the so-called algae, tiny green granules which float in the water and multiply endlessly by division. They are devoured by microscopically small, primitive animal forms, and also by tiny crustacea, the size of a pin's head, which, with the help of two swimming-legs, hop up and down in the water, and are therefore called "water-fleas." On these little crustacea many of the aquatic insects live, and they form the nourishment of small fry, and even the larger fish devour them, and in the sea even the greatest of aquatic animals, the whale, who opens his mouth, takes in water, and then expels it through the sieve formed by his whalebone "beard," so that a living broth of all the little floating creatures remains in his mouth, and is swallowed. To cope with such losses the water-fleas and their marine relatives have to multiply at a simply enormous rate, and in order to make this possible Nature has renounced one of her principles. The small crustacea reproduce themselves *without males*. Females are produced, which lay eggs, from which more females emerge, although the eggs are not fertilized. The numbers of offspring thus produced may best be envisaged if we think of the old story of the inventor of the game of chess, who asked, as his reward, that a grain of wheat should be laid on the first square of the board, 2 on the second square, 4 on the third, and 8, 16, 32 on the succeeding squares—in short, the number was to be doubled for every square. It appeared, on calculation, that all the corn in the world would have been too little to pay him. For that matter, Nature has employed this method of "virgin procreation" or parthenogenesis in the case of other species—for example, some of the larger crustacea, the Gall-wasps, and the Plant-lice. In all these creatures males appear only at certain appointed periods, when they have to fertilize special eggs which take longer to hatch.

Again, the insects which afford nourishment for a number of different creatures multiply very rapidly. But among them are many species which have adopted the other means of maintaining the species. One of the most marvellous creatures in Brazil is the Splendid Phanaeus, a Scarabaeid. How amazed I was when I first saw the insect sitting on a leaf beside the lake of Dos Irmãos in

Recife! No gem could emit more brilliantly-flashing rays of red, green and yellow than this beetle. I took it home, but all its splendour was extinguished when it died. The naturalist Ohaus, observing a female beetle of the Scarabaeidae family, noticed that she covered her young with her body; at night they ran out in order to eat, but towards morning they once more assembled under their mother's body, when the whole family looked rather like a lump of bird's droppings. Such a protective device enabled the beetle, although it produced only twenty offspring, to maintain the species.

A battle may be won either by well-armed and disciplined troops, or by preponderance of numbers. The latter is the simpler method, and so we see that Nature, if one particular species is threatened with destruction, simply throws more animals into the battle-field. It might seem that before the Europeans discovered America the Jaguar and the Rattlesnake must have had the upper hand of the Paca and the harmless Liana-snake. In reality the two latter animals were just as secure of survival as the two former, for otherwise the Jaguar and the Rattlesnake would have multiplied to such an extent that they would finally have perished for want of food. We shall always find that the well-armed or venomous creatures are less numerous than the others.

At the same time, Nature has seen to it that the trees do not grow until they reach the clouds, and that to every living creature is appointed an age-limit which it cannot exceed, even under the most favourable circumstances. The late August Weismann of Freiburg demonstrated, in an interesting essay, that natural death in every species occurs at such an age that the duration of life is precisely that which best secures the maintenance of the species.

On the other hand, reproduction is in a sense self-regulating. Excessive multiplication leads, sooner or later, to degeneration and wholesale death. Plagues of caterpillars and mice do not increase and increase without limit; suddenly a great mortality intervenes, leaving the pests less numerous than before. As for the inner workings of this curious method of regulation, we know as yet very little.

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But one question, which must long ago have occurred to the reader, may perhaps be answered. Could not the whole machinery of life have been constructed on other principles? Was it inevitable that the surplus animals should be cruelly devoured? Might not Nature have resembled a human machine, in which every least part is precisely adapted as its position in relation to the whole demands? Might not the animals have multiplied at such a rate as precisely to fill the gaps made in their ranks by natural death?

On considering the circumstances, we are at once impressed by the great difference between the mechanism of Nature and the machinery of man. The latter cannot be left to itself for decades at a time; it would wear out, and it must therefore always be in the charge of a technical expert. But the miraculous mechanism of Nature has already run for countless ages of terrestrial history, without even losing its energy; all the parts are still vigorous, and any irregularity corrects itself.

But if the worn-out parts are replaced by the mechanism itself, every part of the latter must grow without ceasing, so that new material is constantly introduced in the place of the old. It works, and with it all its least parts, under an internal urge, and it is this urge, this pressure, which finds expression in the reproduction of animal life. Renovation without rejection of worn-out material is impossible, and renovation must needs work with a surplus, in order that it may have sufficient material in hand should there be an abnormal call upon it.

It is therefore an essential characteristic of the vital mechanism of the earth that more animals are born than can ever live. But there are still other intelligible reasons why so many creatures should enter the world subject to the inevitable fate of being devoured or of having to make room for others. So long as every living creature does not attain its goal, so long as this is possible only for a small minority, then, and only then, is there a competition in which each strives to be a winner. In each generation, therefore, there is a selection of the fittest, and only these succeed in bringing offspring into the world, and these inherit only the qualities of the best of the previous generation. On this process depends the increase of vital energy and evolution in form.

When the plane is used, shavings fall to the ground. The earth must continually deck herself with new forms, and place must always be made for them. Since in every geological epoch the climate and soil of our planet undergo change, its animal inhabitants must constantly be recast in new forms, and the old forms must not be allowed to stand in their way.

Lastly, we must not forget that the earth is no paradise. As in the life of man, so in the life of animals, suffering is the rule. And precisely because we see that pain exists throughout Nature, we hope that this world is not the only real world, but that behind it there is something else, some other state in which the suffering that holds the world of living creatures in bondage will be extinguished.

XII

THE MOSAIC OF COLOURS

Harmony is beauty. An organism in which "all parts subordinate their activities to the whole, and each acts and lives in each," must produce on us the effect of a work of art. Not the tiniest little part is superfluous; each has its significance for the whole. Even the good architect seeks to ensure the beauty of his house not by applied ornament, but by its main plan and elevation, and its purposeful construction.

We have seen, in the two foregoing chapters, that Brazil received its fauna countless thousands of years ago, and that its animal inhabitants have subtly adapted themselves to mutual co-operation in the environment of the Brazilian landscape; and it follows that the beauty of the land depends on its native flora and fauna. Nature, in Brazil, is like a vast mosaic. Every plant, every animal is a coloured tessera, a work of art in itself, but whose real significance is first perceived when we see that in combination with the rest it forms a work of art. Consequently, to exterminate any one species of animal is like striking a coloured stone out of a mosaic. The greater the destruction of life, the greater the destruction of the picture. And no one can replace the stones once they have been destroyed, for they come from the hand of One compared with whom man is but a creation, never a creator.

We have seen that the virgin forest of Brazil is characterized by its abundant sunlight and the glitter of its foliage. The Humming-birds, with their bronze-green plumage, are in tune with the metallic lustre of the leaves; and so is the Jacamar, flashing like a great Humming-bird. The Rainbow Tanagers too, and many of their relatives, have a metallic lustre; while the Surucuás, various swallows and pigeons, and the bare neck of the White Ferreiro or Bell-bird look as though their scaly feathers were covered with a verdigris-coloured patina.

Many of the snakes and lizards have a metallic lustre, while others, like the Coral Snake and its harmless relatives, as well as the lovely Emerald Snake, shine as though they were varnished; and so do certain flowers.

Hosts of insects have a splendid metallic lustre. I have already described the Splendid Phanaeus; and there are many great beetles that emit flashing reflections of red and green; there are also large Scarabaeidae that shimmer blue, green, red and gold. There are handsome Weevils whose bronze is covered with a green patina, and some of the Brazilian Cockchafers seem to be wrought of solid gold. The handsomest species of the Bronze Wasps, so called on account of their metallic brilliance, are found in Brazil, and there are also Bronze Bees, at which one can only gaze in amazement when their bodies glitter in the tropical sunlight with a shimmering radiance of green, blue and gold. There is no lack of brilliantly-coloured Dragonflies, and even the family of the Bugs has developed surprisingly lovely species. In the botanical gardens of Rio I used to gaze with ever-renewed delight on a number of Leather-bugs (Homoptera) which inhabited a trail of passion-flowers. These long-legged creatures were bronze-green in colour, with two long yellow stripes along the back; but the hindlegs were expanded in one joint to form violet-purple leaves, adorned with specks of bright red or yellow (Plate 29, II, 4).

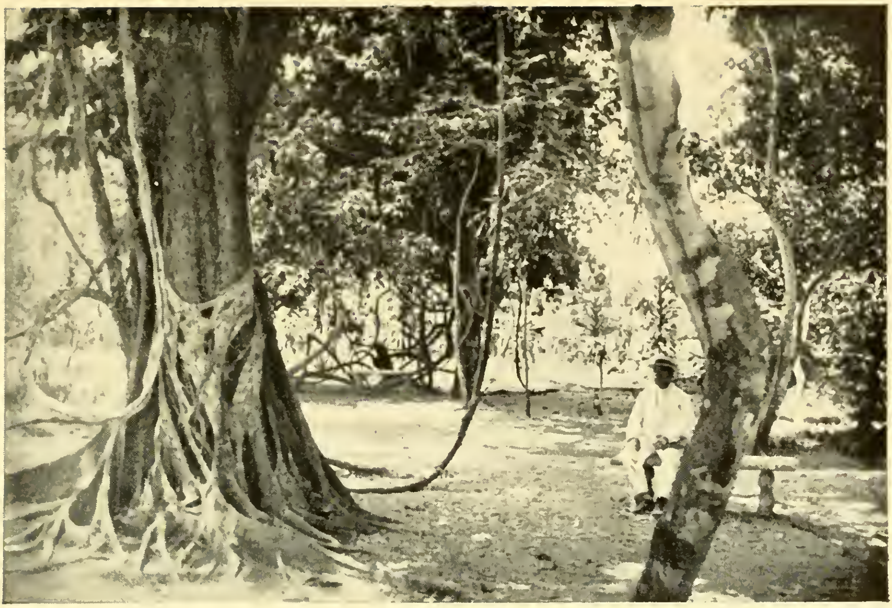
And now the butterflies, as richly endowed with colour as though they were the children of the Sun himself! I have already said enough of the metallic blue of the Morphidae. Even the least emotional and most sophisticated of men could not fail to exclaim with delight when he sees these azure, silken creatures floating through the forest. Those who have seen the Arpsche collection in Rio will admit that no human palette could do justice to the chromatic splendour of the Brazilian butterflies. In many species even the underside of the wings is not only splendidly coloured, but often adorned with elaborate designs, as though an artist had dipped his brushes in a variety of pigments, and had carefully drawn delightfully contrasting circles and spirals on the back of the wings. It is impossible to enumerate all these marvels; I will only mention the fact that some Brazilian butterflies have even contrived to provide themselves with underwings of pure gold, while others are so richly adorned with silver that the species in question is known as the "Money butterfly," Dione moneta.

There are silver spiders too in Brazil. How often have I admired them in the garden of São Bento in Olinda! The great wheel-shaped web is itself beautifully woven, and from the centre four broad rays of spun silk run to the borders like the arms of a St. Andrew's Cross. Where the arms of the cross meet sits the spider, like a work of art cunningly fashioned of silver, from which the raised, red-brown body, itself flecked with silver, protrudes. Other spiders, known as the Thorny Spiders, have a yellow body, glossy as the rind of an orange, and marked with pores like the orange; or it may be bright yellow and covered with spines. Another very common spider is the large, long-legged Nephila, silver, white and green.

But there are other colours, characteristic of the tropics, which have been adopted by plants and animals. When I was in Ceylon it struck me that a colour which is on the whole rare in Europe is to be seen on every side in the tropics. This colour is orange. While in Europe the sun sets in a rosy glow, over the Red Sea, and still more in Ceylon, the western horizon blazes with a splendid orange, especially during the afterglow, when half an hour after sunset a fresh glow is kindled. In Brazil orange tones are not so predominant as in India, but in the Sertão they appear in all their glory.

We have already seen that orange tones are frequent in the flowers, and that even the young leaves of some trees are orange in colour. It is no wonder, then, that we find orange tones in the animal world also. The Indian Underwings are like the European species, except that the underwing is orange instead of pink. There are orange-coloured insects in Brazil, and several species of birds have orange feathers in their plumage. But the climax, where this colour is concerned, has been reached by two birds of the Amazon basin. Goeldi, in his work on birds, describes the Red Ibis, as it sits in its hundreds in the bamboo thickets beside the river, or flies around its mustering-place, in a fairy set-piece of living flames! And in the silent heart of the forest the Cocks-of-the-Rock (Rupicola) execute their dances. The cock bird, the size of a jackdaw, decks himself in blazing orange; a feather crest of the same colour crowns his head. I should be inclined to award these two birds the prize for beauty of colour.

We have seen that a further quality of the tropical landscape is its substantiality. It is full of sharp contrasts; soft shadows and gentle gradations are of rare occurrence. Even among the animals we often find contrasting colours in immediate juxtaposition. The plumage of the Parrots and the Tanagers, and the wings of many butterflies, display such colouring, and as in painting the landscape, so in depicting the birds and animals, one is obliged to work with the finest brushes. Mutually blending tones are rarer than in Europe. For this reason the Parrots—to take an example—would look out of place in a European landscape, whereas in Brazil and Ceylon one feels on seeing them as though Nature, overwhelmed by her creative impulse, had relieved herself by uttering a cry of jubilation.



TREE-STRANGLING FIG, PARAHYBA, STILL GROWING ON THE SUPPORTING TREE

OLD TREE-STRANGLING FIG, MATURE, AT MONTE, OLINDA

At the same time, there is no lack in the tropics of restrained and dignified colouring. Black—at all events, a splendid, intense and satiny black—is more common than in Europe, and is employed by many birds and butterflies with the most dignified effect, interrupted only by a band of red, green, blue or yellow across the wings, or a patch of one of these colours. In Recife, where I witnessed the carnival, it seemed to me that the girls of Brazil had learned a lesson from the Brazilian butterflies. Those nights of festival were incomparable, and are among my most cherished memories. The whole great city was like one vast banqueting-hall; for it is always warm in Recife, though the light sea-breeze was pleasantly refreshing. Along the house-fronts were rows of chairs on which the inmates were seated, and the electric light turned night into day; garlands of lights, white or coloured, were suspended on the house-fronts, or hung across the streets, and the arms of the river were full of gleaming lights. The whole city was full of the fragrance of the *lança perfume*, the scented ether with which the Brazilians spray one another at carnival-time. Down the middle of the street, in endless procession, drove the splendidly-decorated cars, in many of which were symbolic or historical tableaux; but the private motor-cars were the prettiest, for the back seat was always occupied by two or three slender and graceful Brazilian girls, with their dark shingled heads and beautiful, friendly eyes. All were in black silk, but for a green, blue, red or yellow fichu about their slender throats. The cars themselves were often decorated in the same colours. From time to time the procession of cars was interrupted by a troop of indefatigably dancing negroes; and despite the teeming life of the city the whole of the rejoicings were characterized by a certain tranquillity; for there was no alcohol drunk during the carnival! The whole affair was eloquent of the charm of this great, friendly country of Brazil; for me it will always be unforgettable.

Just as the beauty of Nature is an expression of the same activity which has made of the living creature an organism in which every least part co-operates in the harmony of the body, so even the colouring of the animals must have significance in relation to the whole. It must of course be admitted at the outset that there are colours in the animal kingdom whose significance escapes us. For example, the shells of certain marine snails are magnificently coloured, yet they are enclosed by the creature's body, which is expanded into lateral lobes, and therefore can never be seen. Even entrails often display the loveliest colours. But in the case of most colours we do realize that they have been chosen because they are essential to the life of the wearer. The two English scientists, Darwin and Wallace, were the first to recognize the great significance of colour in the animal world.

There are two points of view from which we can perceive and understand their significance. In the first place, the coloration of a living creature is *protective*. Anyone who keeps his eyes open will often have occasion to realize how difficult it is to detect even large animals in a state of nature, because their colouring blends with their environment. Think of green insects in the grass, or brown insects on the trunk of a tree! Protective colouring makes it possible for the animal to make itself invisible to its enemies, but it also enables the beast of prey to approach its victim unnoticed.

But while the animals must be able to conceal themselves from their enemies, they must at the same time be recognized by their fellows. The male must be able to find the female, and the female must know that this time she is not being pursued by an enemy; otherwise the species would not multiply. Consequently the animals have need of tokens by which they can recognize their own species. And it is these signs that make them stand out from their environment, and reveal this presence to their fellows.

Protective coloration and the tokens by which a species is recognized call for absolutely different kinds of behaviour, and it is most interesting to observe how Nature has contrived to accomplish her twofold task. Since the animals possess several senses, the discovery of the mate may, if the biological conditions of the animal permit, be entrusted to some other organ than the eye.

In the mammals the nose is the guiding organ, and so in this class each species has had to evolve a special odour, which becomes intensified during oestrum. This odour leads the seeker all the more surely inasmuch as the mammal moves about on the ground and leaves a scent behind it. Animals of the same species are able to follow such a trail for a considerable distance, and so we may see that not only do the fox and the marten run with their noses to the ground during all their excursions, but that the roebuck too follows his doe with lowered head.

But since the mammals recognize those of their own species by the sense of smell, the outside of the body may be given a protective coloration. And as a matter of fact, the majority of the mammals have inconspicuous coats; brown and yellow are their most usual colours, and these are on the whole the colours of the ground over which they move, or the tree-trunks against which they sleep. For most of the mammals go about their business in the night; by day they sleep, and hence, unless they take refuge in burrows, they have especial need of protective coloration.

But those mammals which, like the birds, have adopted a diurnal and arboreal existence, have evolved on quite different lines. It is as though an active life in the sunlight and the open air had made their blood course more swiftly, for, like the birds, the squirrels and monkeys are very vivacious creatures, and are seldom still. Their special means of escaping their enemies is their agility, and so in them protective coloration is of less importance; indeed, the arboreal mammals would find it difficult to adopt such coloration, as the background to which they would have to adapt themselves is continually changing: now it consists of green leaves, now of brown tree-trunks, and now of the blue sky. In the night, when the animals sleep, they need no protective coloration, since "in the dark all cats are grey."

This being so, audible or visible signals of recognition are all the more important for arboreal mammals. They cannot follow the members of their own species by their odour, since they constantly break their trail by leaping from bough to bough, and no scent will lie in the air. The monkeys, therefore, must rely on sight and hearing. Anyone who has ever visited a zoological garden knows that the monkey-house is always vocal, while among the Ungulates all is quiet. Brehm tells us of a little South American monkey, Leontocebus oedipus, a relative of the Saguim, that he was always impressed by the similarity of its voice to that of a bird. This monkey "sings," now in pure, long-drawn, fluting notes, and now in trills, in every imaginable key. Since this musical monkey has long white hair hanging to his shoulders, like that of a musician, he has been humorously nicknamed the "Liszt monkey."

The Guaribas or Howler Monkeys also sing in concert, and according to Müller-Munchen the result is by no means an unmusical howling; indeed, the Brazilians call it singing. The "chaplain" leads off, at first in short, staccato notes, and then in full, organ-like tones, while the others sing a gentle "accompaniment," as though anxious lest they should drown the chaplain's voice, as a too noisy orchestra may submerge the voice of a singer. The tongue of the Howler Monkey lies above a great bony drum, and the larynx is in some respects not unlike the lower larynx of the bird.

But both the squirrels and the monkeys have visible as well as audible tokens by which to recognize their kind. On the whole, they are more brilliantly coloured than the other mammals; black, white and yellow are often seen; one species of Howler Monkey is red, while the Silver Monkey is dressed in gleaming silvery white, from which his flesh-coloured face and dull black tail stand out conspicuously. At the same time, the monkeys have improved the mammalian face, inasmuch as the eyes have been brought together, so that an object can be seen by both eyes at once, which makes it possible for the monkey to obtain a perspective, and indeed a stereoscopic view of the object; and this is necessary for such estimates of distance as must be made in springing from bough to bough, or jumping across a stream. The horse, which is unable to fasten both eyes on an object, cannot judge distances so well, and this explains why he is given to shying. This juxtaposition of the eyes has of course affected the nose, so that the improvement of the face has resulted in a diminution of the sense of smell; but this, as we have seen, is not so important in the case of arboreal animals as in that of the terrestrial species.

The adaptation begun by the monkeys has been completed by the birds. They are true arboreal and aerial animals; from early morning to sunset they are in almost uninterrupted movement; their blood temperature is higher than that of the mammals, and their sense of smell has degenerated, though sight and hearing are for that reason all the more fully developed.

No greater contrast can be imagined than that afforded by passing from the mammal's gallery in a museum to that of the birds. Here, suddenly, we come upon creatures resplendent with colour, enhanced here and there by metallic lustre. I have already spoken of the dazzling colours of the Brazilian birds; they are indeed incomparably splendid. And these colours are not merely effective when close at hand; on the contrary, they are heightened by the movements of the bird, by the rays of sunlight that fall upon it, by the changing character of the background. One is actually startled when a Scarlet Tanager flies out of a thicket; the sudden appearance of the living ruby is too unexpected for a European. However comfortably I might be sitting in my rocking-chair in the balcony of my room in the Olinda monastery, and however interesting the book in my hand, the excited twittering—*zip*, *wüi*, *zibüi*, *zibüi*, *zibüi*, *visssi*—of the relatives of the Scarlet Tanager always brought me to my feet. Outside, in the garden, stood a Mamão or Melon-tree. Under the crown of great, spreading leaves hung the yellow fruit, and to these the Sanhaçús were giving their attention, driving their slightly hooked beaks into the melons until the orange-red juice oozed forth. Then the light-blue Sanhaçús came flying up, and the other species, with yellow bodies and green and violet wings; the Coconut Sanhaçús were less conspicuous, being a greenish brown in colour. In Rio I often admired the Rainbow Tanagers on the fruits of a Pachiuba palm in the botanical gardens. They glowed like butterflies, green and blue being the prevailing colours of their plumage (Plate 28, Figs. 15–18).

In the case of all these birds it will strike the careful observer that the colours are juxtaposed in large patches. They show no subtle intricacy of design, and if we come to consider other species of birds, we shall find everywhere immediate contrasts; brown wings on a red body, a golden-yellow breast and a black back, a red head on a black and white body, and so on, in infinite variety. The colour-effects of the Parrots are particularly strident; greater contrasts than those of the red, blue and yellow or blue and yellow of the Araras or Macaws cannot be imagined.

But if we wonder why Nature has worked with so broad a brush we must remember that we have learned to regard the colours of birds as tokens by which the species are recognized. These tokens must be recognizable at a distance; fine detail would not help a bird in one tree to recognize a bird in another; its effect would be lost. As Weismann very truly said, the birds are painted, so to speak, in poster style. Our posters are designed to produce an effect at a distance; the object which they represent must be recognizable a long way off; so their colours are vivid, and applied as broadly as possible.

But when we consider protective coloration we find a very different style of painting. Such coloration is a necessity to the Inhambús, for example; like our partridge, they cower on the ground, and above all they must not be seen while they are sitting on their eggs. In the plumage of these birds all possible shades of brown are subtly intermingled, just as they are in the soil on which they crouch. Owls and nightjars also exhibit a coloration which is definitely protective. These birds go about their business by night, so that they have no need of coloured tokens of identity, but by day they crouch sleeping amidst the boughs. Often I have detected an owl only by chance, because it opened its great eyes as I approached it too closely. The nightjars, known as Bacáraus in Brazil, may be recognized by their silent but characteristic flight, their long forked tails, and the white crescent on the throat, or by their singular *rrrrr*, which can be heard at a great distance. By day they press themselves close against the trunk of a tree, or lie at the end of a dead branch, when they so closely resemble the bark that even the larger species may escape detection. Their plumage is marked with the minutest detail; the bark of a tree is scrupulously imitated by its fine streaks and spots as though the bird had been held beside a piece of bark and coloured to resemble it, streak by streak, with a fine brush. But here the appearance of the bird when seen from a short distance has to be considered. A hawk swooping past the bough on which the nightjar is crouching, a panther clambering past it, must be deceived in spite of its proximity.

But there are times when the diurnal birds too sit still for hours at a time, and at such times they have need of special protection, since these times occur at their breeding-season, and if they were detected by their enemies not only their own lives would be lost, but also their eggs and their helpless young. For this reason those birds have the most effectual protective coloration which nest on or near the ground, where their enemies, thirsting for their blood, or their eggs, are most numerous; for these do not consist only of mammals, but of snakes and lizards also, and in particular the great Teju lizard. Not only the Inhambús, but many of the Ant-birds are for this reason covered with an inconspicuous brown pattern.

In the case of other birds, such as the blue Kotingas, the Pipras, the Gaturamos, the blue, humming-bird-like Sahys (Plate 28, 1) and the Humming-birds themselves, the hen bird attends to the duties of incubation, and her plumage is therefore an inconspicuous greenish brown, or some other neutral colour, so that she is hardly visible when on the nest. The male bird, therefore, bears the species- or recognition-marks for both sexes, and in a doubly conspicuous form, and this makes for the preservation of the species, since its enemies are more likely to capture the conspicuous males, which throughout the animal kingdom are almost always in the majority, so that their decimation does less damage to the species than that of the females, whose loss would mean the loss of their brood. Some writers have even spoken of "the sacrifice of the males"; but the sacrifice, of course, is not deliberate but enforced.

In the case of birds of which both sexes display conspicuous recognition-marks, we may conclude that their nests are invisible to their enemies. And indeed, just as in Europe the male and female of the Titmice and Woodpeckers are almost similar in colour, but are able to wear colours visible from a distance, because their eggs or nestlings are hidden away in some hole in a tree-trunk, where their bright plumage is invisible, so those Brazilian birds which nest in holes display colour in both sexes. The Sleepers, Kingfishers, Jacamars, Woodpeckers, Toucans, Parrots and other birds nest some underground, and some in the holes of trees, so that both sexes may display colour without endangering their brood. At the same time, the eggs of these birds are able to dispense with protective coloration. While the eggs in open nests are brown or spotted, and in any case of such a shade that they tone in with their surroundings of grass or what not, the eggs of the troglodyte birds have no need of colour. The eggs of the Woodpeckers, Owls, Parrots are white as hen's eggs.

Hitherto writers on natural history have stated that the green which occurs in the plumage of so many parrots is intended to conceal them when surrounded by foliage, and have endeavoured to support this theory by pointing to the evergreen foliage of the tropical trees. But this belief was born in the study, and depends on the hypothesis that the green of the tropics is like the green of our European trees. This, however, is not the case, and I continually noted, in Ceylon as well as in Brazil, that the Parrots, in their grass-green plumage, stand out very plainly against the darker green of the glittering tropical foliage. These birds, of course, are among those that nest in holes. In New Guinea there is a species of parrot (Eclectus pectoralis) of which the male is grass-green, while the female is scarlet. If the green were protective it would be impossible to understand why, in contrast to all other birds, the male should be clad in protective colours while the female is conspicuously clad.

Yet other subtleties may be observed in the colouring of birds. Since the arch-enemies of the smaller birds are the hawks, which circle in the air and fall upon their victims from above, the back of the hawk is usually less light in tone than the underside. As with us there are redbreasts, bluethroats, whitethroats, etc., so a survey of the Brazilian birds will show that if the conditions of its life demand both protective coloration and recognition-marks in the same bird, the former will occur on the back and the latter on the throat, breast and belly, which generally show the most brilliant tones. These colours are concealed by the sitting bird, and only the back is visible when the bird is on the nest.

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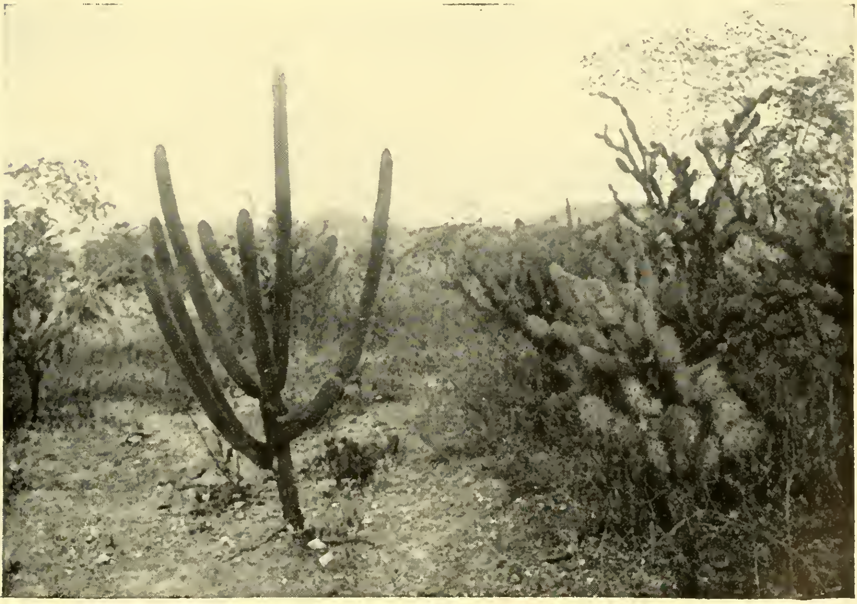
If the animals are to be brought into prominence by recognition-marks, these must contrast with the colour of the creature's natural environment. Such colours are like the high-lights which the artist puts in a picture, in order to give emphasis to the general tone. Now, we have seen that tropical Nature is more brightly illuminated than the European landscape; and the colours of the birds and insects emphasize its brilliance. While in our twilit beechwoods the Clouded Yellow butterfly may flit past, followed by the light yellow Fritillary, we find in the glittering tropical forest a preference for deep or even quite dark colours. I have already spoken of such dignified hues seen against dark backgrounds. Some of the birds of prey are black, like the Urubús or the handsome Cauã Buzzard, and so are the Muturús; and the black of these forest fowl is emphasized by the red or yellow beak. In like manner the red, white or yellow heads of the Pipridae stand out in relief from the satin-black body, as does the red shoulder of the Soldado or the golden-yellow rump of the Checheou. This glossy black offers a splendid and conspicuous contrast to the sunlit glitter of the forest through which the birds fly.

The butterflies of Brazil are the counterparts of the birds. They too are children of the sun, and live their lives in the light of day. They seek their food in the nectaries of scented blossoms, and in amorous play the male and female flit through the flower-bedecked landscape.

There are few living creatures of such striking beauty as the butterflies of Brazil. Even by reason of their size, which is often many times that of our European species, they seem like children of the sun, with glossy silk or satin pinions, and in the larger species their flight is an exquisite libration. A blue Morpho shines in the virgin forest as though it had come direct from the heavens. Other forms of this species have black borders to their blue wings, as, for example, the Bahia Morpho, which I used to admire in Pernambuco. In the Papilio group, to which the European Swallowtail belongs, the ground hue, in Brazil as in India, is usually black. The Sesostris has sheer satin-black wings with one emerald spot on each fore-wing, while the female has fiery red marginal spots on the hind-wings. The Agavus of Rio and the Hectorides of South Brazil

IN THE DESERT OF PARAHYBA



PILLAR-CACTUS AND FIG-CACTUS

have longitudinal stripes of white across the wings, a row of red spots on each hind-wing, and long tails. The Brazilian Hectorides is very like the Hector which I so admired in Ceylon.

We find similar colour-schemes in butterflies of other groups. The dark Didonis biblis seems to have dipped the hinder edge of its wings in blood, and in the great pearly South American Prepona a broad green stripe merges into a splendid shimmering violet before it is absorbed by the black ground-tone. The great Agrias displays a quite indescribable chromatic splendour: as though a Böcklin had amused himself by laying the most radiant red and blue conceivable on the dark upper surface of the wings, and by covering the yellow background of the under surfaces with labyrinthine lines and specks of black and blue. Standinger calls these butterflies the royal family of their group.

But I must not linger over these glorious butterflies, however vividly their shimmering colours appear to me as I name them. Their effect was often intensified by their presence in great numbers. In Nova Friburgo the long, narrow Colaenis Julia, in colour a luminous orange-red, floated everywhere amidst the trees, a continual illumination, which the eye followed with delight; round a flowering shrub in Pernambuco swarms of Anartia amalthea fluttered, in colouring not unlike our Red Admiral, and in Olinda I once saw swarms of Pieris passing for hours on end, for all the world like a driving fall of snow. What caused these creatures to migrate is still a complete mystery.

The most conspicuous of the Lepidoptera of Brazil are a whole series of butterflies whose chief peculiarity is that their wings are long and narrow, so that the flying butterfly has the look of an aeroplane. This similarity is increased by the fact that the butterfly seems to be driven by a propeller, for while most butterflies flutter, that is, clap the wings together above their bodies and open them again, the wings of the butterflies in question always remain extended, so that the form of the insect never alters. On closer inspection it looks as though the extreme tips of the wings are moving. In any case, the insect has a very remarkable flight, which makes it all the more conspicuous (Plate 29).

There is a whole series of families of such "aeroplane butterflies," all typically South American; indeed, one group of them has been named the Neotropineae. Some of these butterflies have wings like yellow glass framed in black borders, reminding one of a stained glass window (Plate 29, I, 8). These are the Methonae, the Therididae and the Ithominiae. The Ceratiniae and the Mechanites are mostly small forms of an ochreous yellow, with black veins and light yellow spots on the fore-wings. They include an absolutely incredible number of species, and Wallace long ago reported that new species were often encountered every few miles, and many small areas of forest, not even separated from one another by hills or streams, have their own species, which occur nowhere else. Black, ochre and yellow are the colours likewise of the Lycoreae (Plate 29, I, 1), but these are larger insects; while the Heliconius family contains the handsomest forms of this butterfly (Plate 29, I, 4).

Among them are black butterflies with a blue lustre, and yellow borders to the wings; others, like Heliconius phyllis, have a large fiery-red patch on the narrow black fore-wings, while a broad yellow streak runs diagonally across the under-wings, a narrower streak crossing the fore-wings. This Heliconius was common in the virgin forest of Pernambuco. These beautiful soberly-coloured creatures, flying slowly over the ground or the undergrowth, apparently without ever moving their wings, contributed not a little to the atmosphere of the glittering forest, adding a dreamy, peaceful note to the majestic scene.

As a matter of fact, Nature may very well have intended—if for once we may speak in such a fashion—to give the Heliconiinae and other "aeroplane butterflies" a slow flight, and to make them plainly visible by their characteristic markings. For these creatures have a means of protection against the many enemies of their kind, who would otherwise be glad enough to devour them: namely, they have an unpleasant smell, and apparently a bitter and nauseous flavour. I once took a pupa home with me—it was marked with black and yellow—and when a Methone emerged from it, with its black-bordered glassy wings, the glass case smelt as strongly of urine as a fox's earth or a mouse-cage. Now if these butterflies are nauseous it is evidently to their advantage that the enemies of butterflies in general should recognize them immediately. Hence the bright colours and the slow flight, which never conceals the markings! If a Heliconid were to fly quickly past a bird, and the latter, in the excitement of the chase, were to snap it up, then, even though it at once rejected its acrid prey, the action of the protective measure would be too late. The butterfly must warn its enemies from afar. Now, we find that these butterflies prefer black and yellow, and resemble one another in shape. Consequently a bird has no need to acquire the same unpleasant experience in respect of every species, destroying a butterfly each time. One experiment with one species is enough; the other species, which have much the same appearance, will profit by it.

But the scientist who turns his attention to the protected butterflies of Brazil may discover still more remarkable facts. When Bates, who, in the middle of the nineteenth century, spent eleven years in exploring the banks of the Amazon and its tributaries, swept his net one day through a swarm of Heliconiinae, he found, to his surprise, that he had caught a butterfly which looked like a Heliconius, but revealed a different innervation of the wings. The various groups of butterflies are recognized by this innervation, and the wings of the captured butterfly showed that it belonged to quite another group; namely, to the Pieridae, which have many representatives in Europe. Being on the alert, Bates, and subsequently other explorers, looked into the matter, and to-day we know that there is a whole family of South American Pieridae which bear a striking resemblance to the protected butterflies, and in shape and colouring are quite unlike the rest of the Pieridae. Their wings are long and narrow; one species, Dismorphia orise (Plate 29, I, 9), has, like Methone, glassy yellow wings, rimmed with black; another, Dismorphia or Leptalis amphinoë, has black, ochreous, and yellow markings, in imitation of the Mechanitis butterflies (Plate 29, I, 6), while other species have selected other models. In many of the Pieridae the form and colouring are such that one can no longer recognize their descent, but in Dismorphia orise we see, on the upper part of the hind-wing, a last vestige in the shape of a white dust (9), while in Dismorphia arsinoë the female has no characteristics of the Pieridae, although the male has a considerable white patch on the hind-wing (5). Still more conspicuous is the difference in the case of Perhybris pyrrha (Plate 29, I, 2, 3). Here the female has clothed herself entirely in the black, brown and yellow costume of the protected butterflies, while the male is an obvious Pierid, very like our Cabbage White. But if one turns him over one sees on the underside of the hind-wing an ochre-brown stripe edged with black, the beginning of the Heliconius livery.

Bates, nearly eighty years ago, recognized the fact that these Pieridae had probably adopted their colouring for protective purposes. The Pieridae are highly appetising butterflies; in many species, indeed, the males are fragrant as flowers. They are therefore eagerly devoured by birds, lizards, and other enemies, and only their rapid multiplication makes up for their losses. In Brazil, however, a few forms have found another means of preserving their species. Since they have adopted the appearance of the Heliconiinae, and fly only in the company of the latter, their enemies regard them as nauseating mouthfuls, and leave them alone. At the same time, they are rare, and this rarity is essential, for otherwise the birds might gradually come to realize that not all the "aeroplane butterflies" are inedible. But in some forms the male has not yet assumed the protective costume; and we can understand why this is when we remember that for the preservation of the species the protection of the female, who is laden with eggs, is more important.

There are still other butterflies which have assumed the black, brown and yellow costume. For example, Protogonius, which belongs to the Leaf-butterflies; but its shape, of course, does not resemble that of the Heliconiinae. Phycioides, however, a relative of our Mother-of-Pearl butterflies, imitates the Heliconiinae closely both in shape and in colour. Even among the Blues a few species seem to be on the way to resembling the protected butterflies, and in the Pericopis family (Plate 29, I, 7) we actually find moths which look like Heliconiinae and fly by day. The attentive observer will of course recognize the insect immediately as a moth by the fine, pointed antennae, for the antennae of the butterflies are club-shaped.

When protected species are imitated by others, which by assuming the same appearance enjoy the same protection, the imitation is known as *mimicry*. Mimicry is not confined to the New World. A family widely distributed through all the regions of the tropics, and protected by a repulsive odour, is that of the Danaïdae, handsome brown and yellow butterflies, which have a superficial resemblance to our Painted Ladies. There are Danaïds in Brazil, and there they too fly slowly, but not at all as the Heliconiinae fly; for they hover in the most curious manner, rocking to and fro without moving their wings: a most enchanting sight. In America, as in India, butterflies of other families have borrowed the magic mantle of the Danaïdae.

Among the beetles too we find similar cases of mimicry. There are beetles in South America which are so widely disseminated that they actually give the fauna of many districts its peculiar character. These are the Wolf-beetles (Plate 29, I, 12). These insects also excrete a nauseating liquid, so that they have few enemies; they can be recognized at some distance by their wing-covers, which are longitudinally fluted, and yellow with transversal black stripes; they lie flat on the body, and are larger than the latter, so that they seem to be unfolded. The beetle constantly raises and jerks these wings, so that it catches the eye at a distance. We have already seen that protected animals derive an advantage from drawing attention to themselves.

The Wolf-beetles are imitated by beetles of quite different families (Plate 29, I, 13–15). These are beetles with the same black and yellow markings, and the same habit of lifting and depressing the wing-covers. Even a Capricorn beetle has adopted this disguise. Its long antennae might betray it, so it turns them back. And there is even an insect of quite another race, a Burnet-moth, which disguises itself as a Wolf-beetle. This belongs to the family of the moths, so common in Europe, that flutter across our meadows, their antennae curled like a ram's horns, their narrow wings a purplish black, and spotted with red. In Brazil the family is peculiarly rich in species, and resplendent with lustrous golden hues.

Another beetle is actually known as the Mummer, because its hump-backed figure reminds one of a Leaf-bug, and like the latter it excretes a stinking fluid. This beetle too adopts the warning black and yellow stripes of the whole group. But the Mummer is imitated by a second insect, a harmless Capricorn, which has carried the imitation so far that even the two red specks on the roots of the wings are not lacking. We shall find that black and yellow, often with the addition of red, are everywhere employed as signals of warning, or for purposes of intimidation. Even in Europe the Salamander is black and yellow, and the Speckled Toad has the same spotted belly, which it displays, throwing itself on its back, when in danger of capture. Both animals excrete an acrid fluid.

The venomous Coral Snake of Brazil likewise shows resplendent cross-bands of black, red and yellow. And two species of harmless adders, which like the Coral Snake live in the ground, have precisely the same colouring. I kept one of these adders in my room, always delighting in its gleaming colours, with their fine steely radiance; they seemed absolutely to shine when the snake had shed its skin. One night I heard something thump on the floor, but I went to sleep again, and when I got up in the morning I realized with regret that my Coral Adder had regained its freedom.

Insects provided with a sting, and therefore dreaded by many creatures, have a number of imitators. The Wasps have the warning cross-bands of black and yellow on their abdomens, and are members of the "assurance society" of protected creatures, as Weismann has aptly called the insects which, in the common interest, wear a common livery. Various species of Capricorns, Weevils and Buprestidae have adopted the black and yellow signals, and many forms endeavour, by the constriction and deportment of the body, to imitate the dreaded sting-bearers.

A very great number of flies and butterflies imitate wasps, bees or hornets. In the case of the flies no extensive modifications of the body are necessary to ensure deception; they have, like their models, transparent wings; only one pair, of course, whereas wasps and bees have two pairs (Plate 29, II, 19, 15). Among the butterflies the Burnet-moths already mentioned are shaped like the Wasps, while another group, the Glasswings, have lost even the scales of their wings, and fly from flower to flower on transparent pinions. In these forms the likeness to the bees and wasps is often so great that even the expert is continually deceived (Plate 29, I, 10, 11).

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Much more numerous, however, than the insects which imitate other insects are those which imitate lifeless objects, or leaves, twigs and flowers. The distance to be travelled is shorter; once a protective coloration is assumed only a few steps have to be taken; the modifications of colour are followed by modifications of form. Here again it is the insect world which affords innumerable examples of such evolution, and once more they occur chiefly in the tropics, where the greater wealth of forms offers greater scope. The insects of Brazil, in particular, must amaze the attentive observer, who suddenly recognizes as a living creature what at first appeared to be a fragment of bark or a leaf. But he must, of course, keep his eyes open. An American engineer with whom I spent some days wandering through the mangrove-woods near Tamarandé in Pernambuco, and who astonished me by detecting, at a considerable distance, an iguana amidst the branches of a lofty tree, told me that he had trained himself to note movements only. Now he was always aware of the very smallest movements. This I could understand, for animals pay more attention to movements than to anything else; I often found that deer or foxes would come quite close to me if I did not move, even if I were standing in an open meadow or in the middle of a path.

Let us now make a survey of the insect world, in order to realize how far Nature has endowed certain groups with the arts of mimicry.

Over the pond the dragonflies pass and repass with whirring flight, now and again falling upon some insect, and eating it as they hold it between their legs. Male and female, each bearing tokens of its species which can be recognized at a distance—in Brazil one species has splendid red wings, and the wings of another larger species are golden-yellow, and rimmed with black—chase one another, and finally cling together, and climb down a reed in order to lay their eggs under the water. From these eggs the young dragonflies emerge in a wingless state; they look like bits of broken reed; and they wear a mask, which enables them to creep along the bottom of the pond unnoticed by their prey, and to seize it with their suddenly protruded underlip, which is formed like a pair of tongs. Such immature forms, which do not resemble the adult insect, are known as larvae. At every moult the wings grow a little longer, until the larva ascends to the surface, where its skin splits open, and the dragonfly launches itself upon the air.

There are masters of mimicry in the family of the Locustidae. These insects afford a nutritious and agreeable diet for many birds, mammals, reptiles and other insects; they have therefore to reckon upon very heavy losses, which cannot be made good save by the most successful adaptation to the environment, and profuse multiplication. The eggs are commonly protected by burying them in the ground. Such is the habit of the notorious Migratory Locusts of Southern Brazil, which from time to time appear in such colossal numbers that their swarms obscure the sun, and the fields are laid completely bare for many miles around. In the Argentine a swarm of Locusts was observed which was sixty miles in length and twelve in width!

I never noticed the huge locusts which were so common in the coastal bush of Pernambuco until they flew off, unfurling their red hind-wings. Directly they settled these were furled, and covered by the green fore-wings, so that the insect was lost in the surrounding foliage. But there are in Brazil certain "Leaf-locusts," or "Leaf-insects," whose mimicry of leaves is perfect in its smallest details. The fore-wings of these insects are held perpendicular, so that when they settle on a twig the wings represent a perpendicular leaf, and the sunken head the leaf-stalk. The wing has precisely the shape of a leaf, and ends in a point; a long vein, with smaller diagonal veins which run across the wing, represents the innervation of a leaf (Plate 29, II, 2). One species mimics a withered leaf with its brown wings; another mimics a green leaf with brown and yellow mottlings at the tip, so that a partly withered and mildewed leaf is represented with amazing accuracy. In another species spots of mildew are seen at the centre of the leaf, which is slightly dished, as though it had warped on withering. Anyone who examined the detached wing of such a Leaf-locust would infallibly take it to be an actual leaf, even after close examination. But once the insect takes to flight it displays, on unfurling its silvery, glistening hind-wings, the identification-marks of its species. One species has the hind-wings streaked with brown, and on each wing is a large, beautiful eye, like the eye of a peacock-feather (Plate 29, II, 2).

Some of the Praying Mantises bear an astonishing resemblance to green leaves. These are locusts whose fore-legs are held up as though in prayer, though their actual function is to catch other insects, which are held as in a vice by the hinged legs, and then devoured at ease (Plate 29, II, 1).

For strangeness of form, the Stick-insect may be ranked with the Leaf-insect (Plate 29, II, 16). These insects, which grow to a length of 8 inches and more, have thin, rounded bodies, and resemble a twig so exactly that even Wallace could not believe that he was looking at an insect when a native brought him one of these curious creatures. The Stick-insects, moreover, instinctively keep their legs pressed close against their bodies. and stretch out their fore-legs before them, still further prolonging the twig-like body. Their mimicry is so painstaking that where the fore-legs run under the head a recess is formed to admit the head, so that no prominence breaks the outline of the apparent twig (16). But many of the Stick-insects find that even this disguise is not enough! If in spite of it they are detected by an enemy, they eject a spray of an acrid, burning fluid, which is said to possess so intolerable a stench that one cannot go near the insect.

Unpleasant odours have been evolved as a means of defence by still another order of insects: the Bugs. Their stinking exudation is really an excellent means of intimidation, for if anyone eating raspberries ever puts one of these insects into his mouth he will pick the berries with twofold care thereafter, and will avoid even touching such Tree-bugs. With such a means of defence, the insects can safely permit themselves the most brilliant recognition-marks, and as a matter of fact the bugs of Brazil, and especially the Shield-bugs and Leather-bugs, are most beautiful insects, whose bodies often gleam with a splendid metallic lustre (Plate 29, II, 4). There are also bugs which protect themselves by their mimicry of bark. It is almost impossible to detect such a Bark-bug when it is adhering to the bark of a tree (Plate 29, II, 3). The body is so flat that it hardly rises above the level of the surface to which it adheres; moreover, the upper surface is roughened and corrugated, and its colour precisely matches the surrounding bark. Even when removed from the tree, anyone would take the insect to be a lichen-covered fragment of bark.

The Cicadae are relatives of the Bugs (Plate 29, II, 6). In this group the Thorn Cicadae are worthy of attention. In these little creatures the scutum is developed into two long upward-pointing thorns, so that when they are seated on a twig they are naturally overlooked, as they seem to be simply thorns growing on the twig. Brazil is rich in these remarkable little insects, which assume an incredible variety of forms: sometimes they are adorned with spines, toothed wheels, and other singular outgrowths.

In the Butterflies Nature seems to have sought to adorn the landscape with jewels, with a species of flying flowers. But the world is no place of peace and tranquillity; other insects, spiders, frogs and lizards hunt the defenceless butterflies untiringly; birds capture them in order to devour their succulent bodies, having nipped off their gleaming wings, which for them are only troublesome accessories; and the caterpillars have still more numerous enemies. The Lepidoptera, then, have need of a very thorough form of protective coloration. At the same time, when they sail through the air they must not fail to display their characteristic species-marks. Nature has been able to solve both problems—by applying the protective coloration to one side of the surfaces at her disposal, and painting the other with the signs by which the species is known. In the case of the Butterflies the latter are painted on the upper surface of the wings; when the insect is at rest it clasps its wings together above its back; the coloured surfaces are concealed, and only the underside of the wings is visible; and this bears the protective coloration. In the Moths, the vivid colours are set on the upper surface of the hind-wings, in accordance with the different position of the wings. The fore-wings cover the hind-wings as with a roof, and they consequently bear the protective coloration on their upper surfaces. As in the birds, so in the moths and butterflies: the protective coloration, which must be effective even at close range, is full of fine detail, while the characteristic signals are applied to wider surfaces, in broad stripes and patches, which can be seen at a considerable distance.

In all the stages of their development the Lepidoptera profit by protective coloration. The eggs are mostly green, like the leaves on whose underside they are laid. The caterpillars assume the colour of their environment; diagonal or longitudinal stripes add to the difficulty of detection. Many caterpillars feed only at night, and by day, as I have already described, gather together in great clusters, which mimic the bark of trees, or merely arouse distaste. The large caterpillars of certain of the Bombycidae (Hyperchiria) or Silk-moths have jet-black bodies, on which the yellow hairs have an uncannily vivid appearance. We have already seen that black and yellow are warning colours, and as a matter of fact these caterpillars burn the fingers if they are handled. Before pupation they spin a cocoon. In the emerging moth the upper surface of the fore-wing is shaped and coloured like a leaf, but the hind-wings bear great eyes, which are so finely shaded that they seem actually to stare from the wings, and many birds might well be frightened if their intended victim were suddenly to unfurl its hind-wings.

Other caterpillars construct a sort of bag with small fragments of wood, and spin their silk around it. The body of the caterpillar remains inside the bag. I found one species whose bag was as big as one's finger, and hung downwards in a singular fashion when its wearer crawled along a twig.

The largest of all the Lepidoptera is a native of Brazil: the Great Owl moth, whose wings have a span of 11 inches. Despite its great size, the sitting moth is very difficult to detect, since its white wings, covered with wavy lines and specks of black, resemble the bark of a tree. It is said to be so shy that it flies off at the slightest crackle of a twig; so that the Indians shoot it with the blowpipe.

Since the wings of butterflies are particularly well adapted to assume the shape and colour of withered leaves, we need not be surprised that Nature has employed this means of protection. It is true that Brazil has no such perfect mimics of foliage as exist in India, where the Kallimae imitate leaves so perfectly as absolutely to defy detection, but the South American families of the Anaeae and the Siderones nevertheless have remarkable gifts of mimicry. When these insects fold their wings they assume the likeness of a brown, yellow or green leaf, traversed by a few rather faint veins. A few specks of mildew have not been forgotten. In flight, the butterfly shows the vividly-coloured upper surface of its wings: brown and blue, with light-blue spots, or red and yellow, or dark-red, enlivened by bright-red cross-kernels.

As sting-bearing insects the Wasps and Bees have no need to conceal themselves; but they are, as we have seen, the models for other insects; and in particular for the Flies, which do not make much use of protective colouring.—Brazil, by the way, boasts of the largest flies in the world; great flies with bodies as long and thick as one's little finger, which resemble the great hornets of which I shall presently speak (Plate 29, II, 15).—The Beetles, however, offer a rich harvest for those who wish to study protective coloration. There are all sorts of green beetles, and others coloured like the bark of trees, and some whose bodies have even the rough and irregular surface of bark. The Weevils especially are past-masters in such adaptations. Among them are forms like the Brenthidae (Plate 29, II, 5), so long and thin that the insect resembles a twig. The Capricorns too contain many species which in form and colour show the most successful adaptation to their environment.

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When night falls over the landscape protective coloration and characteristic markings are lost in the general obscurity; only the white of nocturnal flowers interrupts the shadows, while the bats and nightjars betray their identity by the manner of their flight as they shine against the lighter sky.

But suddenly signals blaze and blink which can be perceived further than the brightest colours in the daytime. The fireflies have begun their play: the fitting and visible expression of the bewildering magic of the tropical night. Before ever I came to Brazil I had seen in Ceylon the scattering sparks of the fireflies above the dark meadows, and the thousands of green lights glittering in the trees, which were thus transformed into very Christmas-trees; an unforgettable spectacle. In Brazil I was once more to enjoy the play of the green lights. In Petropolis, on New Year's Eve, as I walked through the gardens in the fragrant summer night, the lawns were as though illuminated, and with astonishment I noted how hundreds of green lights blazed out *simultaneously*, and were simultaneously extinguished; with so regular a rhythm that it seemed as though the sparks were blown upon by a huge mechanical bellows that gave a puff every second. Of this extraordinary rhythm I could discover no explanation.

The species of firefly or luminous beetle which I have just described has, like its European relatives, a luminous organ on the underside of the last two segments of the abdomen. The light is produced by a substance which is decomposed, or rather oxydized, by the oxygen in the spiracles surrounding the organ, under the control of the nervous system. The rhythmical appearance and disappearance of the light, which is seen in the Indian fireflies also, is due to the movement of the terminal segments, which now conceal the luminous plates and now uncover them. The function of this rhythmical illumination is to attract the attention of other fireflies; just as in the streets of our cities the luminous advertisements catch the eye by continually appearing and disappearing. It may also afford the insect a measure of protection, for it has been observed that the Carabid beetles leave the fireflies alone. A frog, however, would not be intimidated by their light, which would only draw his attention to his prey.

But besides the small fireflies, there are in Brazil much larger luminous beetles, which belong to quite a different family, namely, to that of the Elateridae (Plate 29, II, 8). I was once sitting on the verandah of a lonely house in the forest of northern Pernambuco, when such a beetle came flying up; it had two greenish-blue lanterns on its shoulders, so that it seemed, like a locomotive, to be lighting its own track. It was a magnificent sight: especially when more of these living aerial locomotives came floating up and flying across the verandah. I have caught such luminous beetles, some species of which have a third light on the underside of the body; even by daylight the luminous organs were perceptible as yellow spots on the hinder edge of the brown scutum or neck-shield, and they blazed up at once if I carried the long narrow beetle into the dark. I always kept such a "cucujo," as the insect is called in the West Indies, in a glass on my bed-table, so that I might be able to tell the time in the night. It filled the whole room with a faint green light, which was intensified if I shook the glass. The explorer Dubois succeeded in isolating the luminous substance of the "cucujo," and he ascertained that it gave less than one-four-hundredth part of the heat given off by a Bunsen flame of the same candle-power. Wasmann facetiously suggested that it might one day be possible to prepare pills of "cucujin," which scholars might swallow in order to be able to work by the light of their own bodies. I have been told that burglars have sometimes rubbed their faces with the green luminous substance, in order to frighten the inmates of the house they were entering. In 1634, when Sir Thomas Cavendish and Sir Robert Dudley, in command of the English fleet, proposed making a landing in the West Indies, they saw innumerable lights moving about on the shore, and drew off again, concluding that the Spaniards were approaching with an army of torch-bearing soldiers.

Both the male and female shine, and even the eggs and larvae. In South Brazil there is a beetle, one of the Malacodermata, whose female, 2 inches in length, emits a coloured light. Explorers who have encountered this grub-like creature creeping over the floor of the forest have spoken with admiration of its fairy-like appearance. The first segment of the body glowed like a red-hot ball of iron; the rest of the body followed like a broad blue, or sometimes yellow, streak of fire, and the constrictions of the segments gave it the appearance of a string of gems. Whenever the insect stretched forth its head one saw that the red stripe that ran down the back was continued on to the head, and since the unlit portions of the head remained invisible it looked as though the beetle was putting forth a fiery tongue, and groping about with it.

There is a record of a fourth luminous insect having been found in Brazil. In 1705 the naturalist and painter, Maria Sibylla Merian, reported that some natives of Surinam had brought her some insects, some 3 inches in length, with shapeless, bladder-like heads and wings mottled with green and yellow; but the under surface of each of the wings, when these were unfolded, showed a great dark eye. The lady put the insects into a box. At night she heard a sound, and opened the box, only to let it fall, startled by the discovery that the heads of all the insects were blazing like lanterns, so that one could have read the newspaper by the light emitted. Since then these "lantern-bearers," which belong to the Hemiptera, have often been caught, but they have never been known to shine, so that Fräulein Merian's statement has remained an enigma. Nowadays the majority of naturalists give it no credit, but many are of opinion that the lantern-bearers shine only at certain times, perhaps during the mating-season, as is said to be the case with certain of their relatives in China, and that hitherto only this lady has had the good luck to see the insect at the critical period.

The human eye is an organ born of the light and turning to the light. When night falls upon the earth it still longs for the light, and our hearts greet with joy every spark that breaks through the darkness. And there is something fairy-like and fabulous in the green wandering lights whose bearers remain invisible. They seem like the souls of creatures to which the meadows and thickets have given birth in the silence of the night, and which by their soundless dance express their mysterious emotions.

XIII

THE FLOWERS OF BRAZIL

At the close of my last chapter, I said that the eye is born of the light, and turns to the light. Light attracts the eye; involuntarily the gaze fastens on places where lights gleam, where colours glow. For this reason the characteristic markings which are intended to catch the eye are for the most part brightly coloured. They take the eye captive; it looks at them more and more closely; the background dissolves into a new atmosphere.

Not only birds, beetles, and butterflies bedeck the landscape with coloured high-lights, but also the flowers. And it occurs to us to wonder whether their colours too were designed to catch the eye. For the eye is held by them; and everyone who comes from the tropics is asked the question, whether the magnificent flowers do not constitute the chiefest charm of the tropics.

But the plants have no eyes, and the colours of their flowers cannot give signals by which one plant may recognize another of its kind. What could it profit them indeed if one plant recognized another, seeing that all are fastened to the spot on which they stand? If we are to believe that the colours of the flowers mean nothing unless there are eyes to see them, these eyes can only be the eyes of animals, birds, insects. But if this is so we have yet another proof of the harmonious homogeneity of all the parts of Nature, of the truth of the idea which has been repeatedly expressed in these pages, that no living creature lives to itself, but for the whole, to whose perfection it contributes.

And, in fact, the flora and the fauna of a country belong to one another, and the counterpart of the flower is the insect. We might say that flowers and insects were, in a sense, developed from a single idea when once their time had come, as a fresh enrichment of the painting of Nature, and that here again we perceive her miraculous property of changing, not only from hour to hour, but also from epoch to epoch, like the images of a kaleidoscope, without ever destroying the harmony of the whole.

Not until the end of the geological Middle Ages, in the so-called Cretaceous period, did the flowering plants appear, and only from this period did the insects begin the upward ascent which has led to their present wealth of species. Nature, before that period, must have been poor in colour compared with what she is to-day, and anyone who could have seen the earth during this stage of its evolution would have gazed with astonishment at the emergence of the colours which began to paint the landscape and make it suddenly bright and cheerful.

Since at the end of the eighteenth century the Brandenburg botanist Sprengel discovered the "secret of Nature" as regards the production of flowers, the scientists have sought the solution of riddle after riddle relating to the structure of flowers. The result of all their researches may be summed up in the axiom: The coloured and scented flowers were evolved by the plants for the sake of the insects. The flowers contain the sexual organs of the plants, which, as in the animals, are male and female. But in the plants both organs are commonly contained in a single blossom, which is therefore called an androgynous flower. The male reproductive substance, in the animals known as semen, is situated, in the form of "flower-dust" or *pollen*, on the *stamens* (Fig. 13), which emerge from the corolla of the flower, surrounding a little staff or style (or several such), which is known as the *pistil*. The pistil is a part of the female organs. It begins with the *stigma*, the place where the pollen is received, and ends, in the base of the flower, in a swelling, the *ovary* or *ovaries*, which contains the *ovum* or *ova*. On fertilization the stamen touches the stigma, and a grain of pollen forces its way through the pistil into the ovary, combining with the ovum. The ovum thus fertilized, which is now surrounded with some sort of husk, or even a shell, becomes the seed of the plant, which either falls out of the withered ovary, germinating in the soil and becoming a new plant, or remains in the ovary, which proceeds to grow into a fruit. This fruit is gathered or picked up and eaten by a bird or animal; the seeds or stones fall out of it, or pass through the digestive system, and are then sown by the natural action of the bowels.

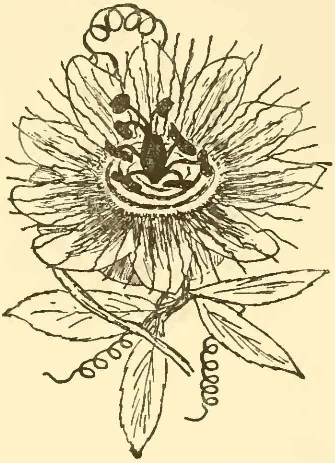


FIG. 13.—Passion-flower or Maracujá. Surrounded by petals, sepals, and a coronet of filaments. The ovary rises in the centre, prolonged into three pistils; around it stand the five stamens with their anthers

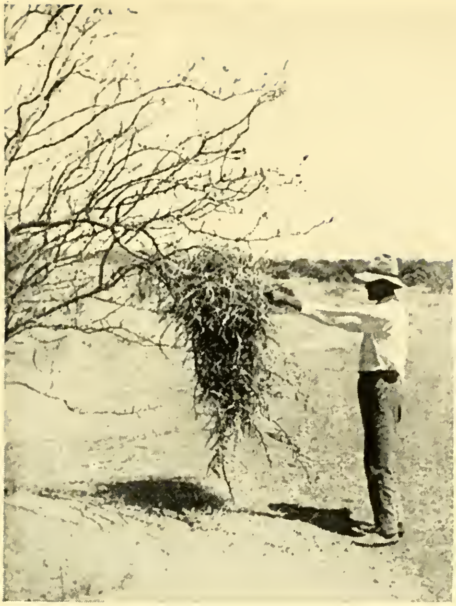
So long as the structure of the flower is as I have described, it is always possible that the pollen may fall from the stamens directly on to the stigma of the same flower, since this is surrounded by the stamens. As a matter of fact, we find many such instances of self-fertilization, but in the majority of cases the plants have tried to avoid this method; as a rule by ensuring that the male and female organs of a flower become ripe at different times, so that when the pollen is ripe the stigma is not yet ready to receive it, but opens only when the stamens of the same flower are withered. But self-fertilization may be made impossible by the positions of the male and female organs. We can understand why the plants endeavour to guard against self-fertilization; for this is the highest imaginable degree of inbreeding, exceeding even the marriage of brother and sister, and examples in the lives of human beings and domestic animals have taught us how quickly inbreeding may be productive of bad results.

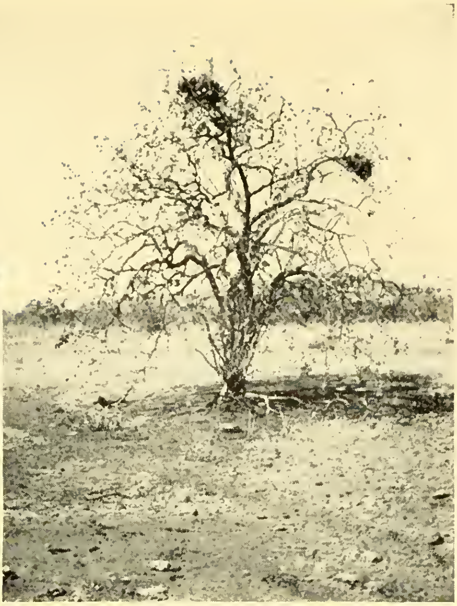
It is therefore to the advantage of the plants if the pollen from the flower of one plant is conveyed to the stigma of the flower of another plant. In the case of many trees, such as the Conifers, the Hazels and the Birches, and also in that of the grasses, the pollen is blown off by the wind and carried far across country. Ponds are sometimes covered with the yellow dust; persons whose mucous membranes are peculiarly susceptible become afflicted with hay fever; and when the air is so full of pollen it is natural that a grain will sometimes fall on the stigma of a plant of the same species.

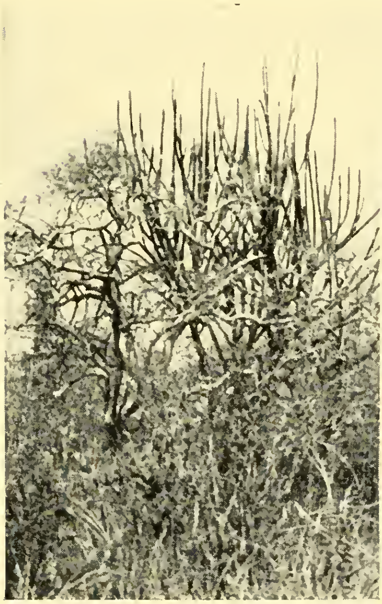
Most of the pollen, however, is lost, so that the plants had to seek some means of getting the precious dust carried directly from flower to flower. Such vehicles were found in the insects, which were able to fly through the air, and were small enough to alight upon a flower without breaking it or pulling it off.

But for their services as go-betweens in this matter of fertilization the plants had to offer them some reward, for otherwise why should the insects ever visit the flowers? The plants therefore began to secrete a sweet, nutritious substance in their flowers—flower-honey, or *nectar*, as it is better to call it, for we give the name of honey to the nectar after it has been elaborated by the bee. Now, the plants had to call the attention of the insects to this nectar, and so they developed, round their blooms, bright petals, which could be seen from a distance, and from the midst of these petals they sent forth a perfume which filled the surrounding air. In this way an increasingly intimate and friendly relation between the insects and the

PLATE XXI


A FERREIRO'S NEST


VULTURE-NETTLE-TREE


PILLAR-CACTUS

OITICICA

flowers was evolved, and presently there were whole groups of insects which had actually transformed their bodies with a view to seeking the new form of nourishment. The bees grew baskets on their legs, which they filled with pollen, and a trunk or proboscis with which to suck up the nectar, and the butterflies, which outwardly resembled the flowers, were also provided with a long proboscis, which gradually assumed such a form that the insect was able to feed only on the nectar of flowers.

But the reciprocal adaptation of the flowers had to be even more elaborate. For if all the insects were to visit all the flowers, they would, as a rule, convey the pollen of one species to the stigma of another, and only by an unusual coincidence would an insect fly direct from one plant to another of the same species. But since fertilization cannot occur unless the pollen is conveyed to the stigma of the same species, the plant would obviously find it advantageous to specialize in respect of certain kinds of visitors. Once it had done so, the selected insect would visit only plants of the same species, dusting itself over with pollen in one flower, and brushing it off upon the stigma of another, and thereby fertilizing the latter. They would—so to speak—put into only those harbours in which their wares were valued. And the insects too would profit by such a restriction, for they might be sure that their special flowers would not be visited by all sorts of other insects, whereby the cup would often be emptied before they arrived. Here again, then, we have an example of the distribution of food according to an all-seeing plan, and the creation of a harmonious work of art, all the parts of which are mutually geared together. We see, too, that in virtue of such reciprocity living creatures which apparently are quite unrelated may be bound together by bonds of life and death. For example, it may happen that in a whole countryside an important plant, such as clover, is dying out, because it no longer produces seed. On closer examination it appears that the seed cannot be produced because the flower has specialized with a view to fertilization by the bumblebees, and that these have disappeared from the neighbourhood. We find the cause of their disappearance in the depredations of the field-mice, which have destroyed the subterranean nests of the bees, and presently we discover that the mice have increased because all the owls and buzzards have been shot. And this crime has been avenged by the disappearance of the clover.

Most of the insects which have been chosen as the fertilizing agents of flowers have one thing in common: a hairy body. With their hairs they involuntarily brush the pollen from the stamens as they creep into the flowers; it remains entangled in their fur, until, when next they enter a flower, it is rubbed off upon the stigma. Many insects, like the bees, even collect the pollen in special combs or brushes on their legs or abdomens, or in special depressions on their thighs, or "baskets," for they require the pollen as albuminous nutriment for their brood. Flowers which surrender their pollen as nourishment produce such an excess of it that plenty is left for the purposes of fertilization. Pollen-eating beetles, which visit such "pollen flowers" exclusively, are always dusted all over with pollen; they cannot clean it all off, and carry it into other flowers. Certain orchids offer, in the place of pollen, a sort of albuminous meal, which they expose upon their underlips, as though on a dish. Other orchids develop nutritive warts and swellings, and by such means they have taken into their service insects which would be of no use to other flowers, as they have no proboscis with which they could suck nectar.

The "nectar flowers," which offer sweetstuffs to their visitors, need not be so prodigal of their pollen, and accordingly they produce less. They can draw upon the hosts of suctorial insects. They specialize mostly in the quantity of the nectar offered, accordingly as they wish to entice deep or moderate drinkers. The American orchid Corianthes produces a most abundant supply of nectar. On the "underlip" of this flower—namely, the petal which stretches downwards, and is slightly turned up again at the point—a little pocket is hollowed out, and from two minute horns the nectar drips into this pocket until it finally holds nearly an ounce of honey.

Another means adopted by the flowers of restricting the circle of their visitors is to place the nectaries in a special position. Any part of the flower may secrete nectar, and by deepening the corolla it may be made less easy of access. Many plants, and especially the Umbelliferae, offer their nectar, as it were, on flat dishes, so that beetles and such flies as visit flowers can alight and lick it up without more ado. In other flowers, however, the petals coalesce to form tubes of varying diameter, until at last only the long trunks of the butterflies or moths can find admittance. In Brazil there is a Hawkmoth whose trunk attains the enormous length of more than 8 inches, so that it is able to enter a corolla of corresponding depth, which no other insect is able to plumb. In America the Hummingbirds also are enlisted for the work of fertilization, and special flowers have been evolved which are adapted to their bills, and even to the bills of a particular species; so that we now understand why the bills of these birds are sometimes short, sometimes long, sometimes curved, and sometimes straight.

The flowers must of course keep the honey intended for their visitors in good condition; they must not allow it to become diluted with rain-water; so they protect it by means of ingenious arrangements of hairs, which turn the dripping rain aside. Moreover, they even take measures of defence against uninvited visitors, who might climb up the plant from the ground, and try to lick up the nectar without conveying the pollen to other flowers. Just as our gardeners protect their fruit-trees by rings of some adhesive substance, or collars of downward-pointing spikes, so the plants surround their flower-stalks with sticky rings, in order to prevent ants from approaching nearer, or rows of thorns, to stop snakes; or they buy such creatures off by exuding another supply of nectar from the stem, near the ground. There are even plants which induce the ants to defend them against other unwelcome visitors, offering them food or a dwelling-place in return for their services.

Even the *attitude* of the flowers is not a matter of chance. The majority of the flowers look up to the sky, since their visitors come down upon them from the air. The Campanulae, on the other hand, look downwards, since in this position they are more likely to attract the bumble-bees, which fly up from the ground, and are all the more eager to visit the bell-flowers inasmuch as they have few competitors, and can count on finding the larder full. The Orchids mostly look out sideways, in order to enable hovering visitors, like the Humming-birds, to reach their nectaries even while on the wing. And the flowers which depend on the Hawk-moths assume the same position, for these insects also feed while hovering. For creatures which are not such expert fliers the Orchids prolong their lower petal into an underlip. This offers the insect a convenient alighting-platform, from which it can creep into the interior of the flower. Many Orchids have developed the underlip into a sort of stool (Fig. 14, 5), on which the visitor can perch while he comfortably inserts his trunk into the flower.

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Even the scent which the flowers give out has been evolved for the delectation of their visitors. While our own nostrils are able to identify a number of flowers by their scent, the insects must have a much more discriminating sense of smell, for they are able to perceive odours at such a distance that a flower is able to attract species of insects which otherwise one would never see. It has been ascertained that bees are able to scent the flowers of the wild vine—which for us are quite without perfume—at a distance of 300 yards; and if a female Peacock moth, who has no scent that our nostrils can detect, is placed in a cage, she will attract, in the course of the night, numbers of male moths, although these are by no means common. And according to the nature of their visitors, the flowers give off their scent by day or by night; indeed, the intensity of their scent varies at different hours of the day.

In Ceylon, one day, as I was walking through the botanical gardens of Peradeniya, I suddenly drew back before a horrible stench of putrefying flesh which filled the air. Looking up, I saw flowers as big as a man's head hanging from a creeper-covered arch (Plate 18). These were the flowers of the Brazilian Aristolochia grandiflora. The flower of this creeper looks like an open bag; the mouth is wide agape, and has the colour of bleeding flesh. This colour, together with the carrion stench, attracts flies; they climb up a long filament that hangs from the flower, reach the edge of the bag, and wander into it, following the scent. But the tubular part of the corolla is set with hairs pointing inwards, which prevent egress, on the principle of an eel-trap. The flies, having once entered, must go on and on until they reach the dilated terminal portion of the flowers, which contains the stamens, as yet withholding their pollen, and the ripe stigma. If the flies have been in an Aristolochia before, they have pollen adhering to them; they rub it off on to the stigma, and accomplish their task of fertilization. Now the hairs of the tube grow limp, and simultaneously the anthers open. The flies cover themselves with pollen and creep out, to repeat the whole act in the next flower they visit. Brazil has quite a number of such fly-fertilized flowers, which assume the most fantastic shapes imaginable. For that matter, the Arums are fertilized by flies, and possess a similar mechanism.

Just as the insects have a preference for certain odours, so they are attracted or repelled by certain colours. Quite recently experiments have been made in this connection, and it has been proved beyond a doubt that insects actually fly towards certain colours, even if these are represented merely by coloured strips of paper, when any possibility of the co-operation of the sense of smell is excluded. It has been shown that bumble-bees and hive-bees have a preference for blue and violet, and other insects for yellow, while red is avoided, being visited only if mingled with a little blue or yellow, as is usually the case. Certain experiments actually seem to prove that insects are "red and green colour-blind"; that is, that they do not perceive red as contrasting with green. In Europe there are hardly any pure red flowers; but in Brazil, as we have seen, there are quite a number, and it has been suggested that in South America the red flowers are visited and fertilized by Humming-birds, which are not colour-blind. As far as my own observations go, I cannot flatly assert that all insects are colour-blind, and prefer to wait until the experiments have been extended to include the Brazilian butterflies and hymenoptera, which I have often seen visiting scarlet flowers. In the gardens of Rio, the parks of Nova Friburgo, and the Horta da Luz of São Paulo are bushes with green, sharp-cornered leaves, on which, in the month of May, great red stars of such brilliance burst forth that one is literally dazzled by them. Such a star is 12 to 16 inches in diameter; it consists of twenty or more flame-red, narrow, pointed leaves, which surround the actual inconspicuous inflorescence. This bush is a Euphorbia, which the Brazilians call "Papagaio"; but they give that name to many brightly-coloured flowers. The assumption that insects would be attracted from a distance by these brilliantly luminous flowers was fairly obvious, and I did see whole flocks of butterflies hovering over the bushes; and great numbers of the splendid Brazilian Swallowtail, the black and yellow Thoas, settled on the flowers in order to suck their nectar. In Nova Friburgo an engineer told me that he was colour-blind, and could not distinguish the red of the leaves surrounding the flower: for him they were indistinguishable from the ordinary leaves. If the butterflies were in the same case, the great attractive power of the "Parrot-flower" was unintelligible.

The example of this Euphorbia teaches us, however, something more. It demonstrates the many-sidedness of Nature, who does not by any means rely upon one single scheme, but applies the most various means to attaining one and the same end. As a general thing the visible apparatus which is designed to attract the insects by brilliant colour which contrasts with its surroundings consists of the flower itself—that is, of its petals. In the Parrot-flower, however, the blossoms are small, inconspicuous cups with yellow rims, and the function of display is allotted to leaves with mid-ribs and lateral innervation. But no flower could attract the gaze more forcibly than these rosettes of large red leaves.

In Pernambuco there was a similar Euphorbia, but this was only a shrub. This too turned its rosettes of coloured leaves towards the sun, but only the inner half of each leaf was a fiery red. The shrub is known locally as "Seems and isn't"—namely, a flower. There is also a grass which bears such a rosette of leaves at its tip—but these are silvery-white. In another Euphorbia the apparent flower consists of two opposed leaves of a flesh-red colour, which are at the same time glands, and enclose the invisible flower. Such a "flower" looks like an umbel; the Brazilians, in reference to the two red leaves, call the shrub "The Two Friends." This shrub is covered with thorns, and is useful for hedging a garden. There are other thorny Euphorbias, with fleshy, cactus-like boughs, which are likewise used for hedging; if one grazes or breaks them in forcing one's way through the hedge, a white poisonous milk gushes out; so that such a "Tirucalli hedge" is impenetrable.

Another very curious Euphorbia is known as the "Leaf-bloomer," because the flowers with which the shrub is covered seem to spring from the edge of the large green leaves. The apparent leaves, however, are merely expanded twigs, which have taken over the work of the leaves, while these have degenerated.

Like foam glowing in the evening sun the wine-red blossoms of the Bougainvillea surge over the walls of the Brazilian gardens to greet the passer-by. Examine one of these blooms: you will find that the actual flowers have nothing to do with this resplendent display of colour; they are small and yellowish-green, tubular in form, assembled in threes, the outer ends of the corollae being slightly divergent. Here again leaves have become blossoms, retaining their shape and their innervation, but changing their original green for a splendid wine-red.

In the Arums too the club-shaped inflorescence protrudes from a bract which surrounds it like a sugar-bag, and this bract is a splendid red, or is spotted with red; and the Gravatás too adorn their inflorescence with handsomely coloured bracts, and sometimes employ contrasting hues of red and yellow. And in the flower of the Indian Cane or Canna even the stamens have to play their part in the make-up of the splendid, iris-like flower; only one stamen carries an anther; the rest are expanded into leaf-shaped forms, and one is turned over like a lip. The Cannas may be seen growing like yellow flags in damp, low-lying ground; others, a lustrous orange-red, or speckled with red, surround the huts of the workers in the sugar-fields of Pernambuco, and the impression produced by their fiery splendour is all the greater if one has just been wandering through the forest of green cane.

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But now for the beauty and wealth of colour of the flowers themselves! What variety of form is achieved by the same arrangement of petals! Here, erect as a taper, rises the honey-coloured, oily, glistening inflorescence of the Cassia from the great pinnate leaves; there the Centropogon bush is covered with great crimson bells; and crimson too are the racemes of the Calliandra, while between the flowers the yet unopened buds are strung like coral beads. This shrub is one of the Mimosas, as one may see by its finely pinnated leaves.

Many flowers add to their effect by their expanse: for example, the Victoria regia, whose flowers are as big as plates, and the Aristolochia grandiflora, whose flowers are so large that children at play wear them as caps. Others assemble themselves in umbels, racemes, panicles and clusters, thereby enlarging the coloured area; for example, the trees of the Brazilian forests seem covered with huge bouquets of flowers. Again, insects are often shown the way to the nectaries by rings of colour.

Flowers have devised yet other methods of permitting only certain groups of visitors to reach their nectaries. Every flower has its appointed season of blooming—that is, of giving access to its interior—and this season always coincides with that of the insects which are expected to fertilize it. Even the time of day plays its part in the opening of the flowers. For the whole animal world does not awaken simultaneously; each creature goes to its day's work at its own appointed time. Every hour of the day some fresh species of insect spreads its wings, until night falls, and the diurnal creatures rest; and then the moths begin to whir through the air. The flowers have adjusted themselves to this gradual unfolding of life; they remain closed until their appointed hour, and save their perfume until their friends can come to them. Then only do they open, and invite their guests with their coloured petals and far-flung fragrance. The great Linnaeus was well aware of this peculiarity, and in the botanical gardens of Upsala he made a "flower-clock"; he planted only species which open their petals at a certain hour, and close them as punctually; and so one could read the time by the flowers which had just opened. Needless to say, the flower-clock was not perfect, for the plants in question do not all flower at the same time of the year.

But we perceive in this flower-clock yet another proof of the unity and harmony of creation. Just as in a play not all the players appear on the stage at the same time, so in Nature scene follows scene, and in each two new protagonists encounter one another, whose characteristics harmoniously complete one another, and who are mutually dependent, although they belong to two different kingdoms.

On my very first morning in Brazil, as I strolled about the monastery garden in Olinda, overjoyed once more to see the tropical sun, my attention was attracted to some small five-petalled violet bell-flowers which were seated in the axils of their leaves. These little flowers were so numerous that the ground all about me was blue with them. I was called away, and decided to examine the plant more closely in the afternoon, but then, to my surprise, all the flowers had disappeared. Not until the next morning did I find them again, and realize that they open only in the morning. The Brazilians call the plant Fleabane, because fleas are supposed to remain stuck on it, and it does actually exude a sticky substance that gives a delicious odour of cedar oil. In August and September the monastery garden was full of the delicate cedar-like fragrance, and even on the monastery farm the air was aromatic with it, so that it was delightful to stroll through the fragrant fields in the evening.

A delicious little hyacinth, which is fond of blooming by the wayside, conceals its tiny blue bells in the afternoon; and the sky-blue flowers of the Commelina too disappear. This charming little plant is as modest and lovable as our own Forget-me-not, and like the latter, prefers a damp situation. The yellow stamens protrude from a green capsule, which contains water, and beside them are two stalked petals of the tenderest pale blue. I have already spoken of the "Nine o'clock Bindweed."

The nocturnal flowers are wonderful. They may be distinguished by their whiteness, for gay colours cannot be seen in the dark; only white is luminous. Like our Honeysuckle and Soapwort, the nocturnal flowers of the tropics exhale a particularly strong perfume; in the night the sense of smell must come to the help of the sense of sight; and the olfactory powers of the nocturnal insects, such as the Hawk-moths, of which Brazil possesses some very large species, are very strongly developed, while it seems to have been proved that these insects are completely colour-blind. To correspond with the long trunk of the Hawk-moth, the flowers that open by night are often tubular in form, and have wide funnel-like orifices, so that the insects can see at once whither they must fly.

By day the scent of all these flowers is not perceptible, but when the night comes their life begins, and it is surprising to note how the splendid Tiger-orchid, for example, will open its blossoms in as little as three minutes. With slight, jerky movements the petals spring asunder, and a faint pattering sound is plainly audible. Another surprising and fascinating plant is the "Queen of the Night," or "Night-blooming Cereus," a Central American cactus, which opens its great flowers—8 inches in diameter, white within and yellow without—only for one night, when they exhale a strong scent of vanilla.

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Since the flowers have so subtly adapted their organs of attraction to the insects, it is only to be expected that the process which constitutes the aim of all these devices should likewise be regulated in the subtlest and most various fashions. And such is indeed the case. The male reproductive substance, the pollen, is produced in the form of a loosely-held dust of tiny grains, exposed upon anthers supported by flexible stamens. The insect must come into collision with the stamens, and dust itself with pollen, and must then force its way past the stigma, the female organ of conception, so that a few grains of pollen are rubbed off upon the latter. We have seen that the stamens and the stigma, with its pistil and ovaries, commonly ripen at different times, so that the pollen cannot fertilize the stigma of its own flower. But there are plants, like the Mamão-tree, the Ombú, and others, which have separate male and female flowers, the first containing only stamens and the latter only the ovary and its accessory parts; and in most cases these male and female flowers are produced by separate plants, so that there are male trees and female trees.

Those wonderful flowers, the Orchids, have evolved a quite special mechanism of fertilization. They do not dust one another with their pollen; for the pollen grains adhere to two little club-shaped anthers or pollinia, which are seated on short stalks or caudicles that spring from a projection above the entrance to the "spur" of the blossom (Fig. 14). The spur is the tubular prolongation at the back of the flower, at the point of which the nectar is secreted. When an insect flies up to the Orchid, it alights on the downward-pointing petal which forms the "underlip" or threshold, and thrusts its proboscis into the spur. In doing so it butts against the projection, and in a moment both pollinia are affixed to its head, like a pair of horns.

The pollinia may be made to spring off and adhere to a pencil or a needle if this is thrust into the spur; when withdrawn, the two little horns will be seated upon it. As the insect flies away, the pollinia, actuated by an internal mechanism, bend forwards, and when the insect visits the next flower they inevitably strike the stigma, to which the pollen adheres, whereby fertilization is effected.

In the Silkweeds or Milkweeds (Asclepiadeae) there are tiny gins or "pinch-traps" which adhere, with the pollen, to the feet of the visiting insect; and these gins are actually set in slots into which the insect is obliged to put its feet, as the petals are smooth and slippery. In other flowers the stamens are like turnpike bars; they fall down upon the entering insect when it touches a spring in the vestibule of the nectary. The flowers of the Fig-cactus too have a fascinating mechanism. From a pit filled with nectar rises the pistil with its stigma, and the stamens stand around it in a circle. When an insect arrives it settles on the stigma and tries to climb down to the nectar. But in doing so it touches the stamens, and these are so contrived that on being touched they curl over in groups, and

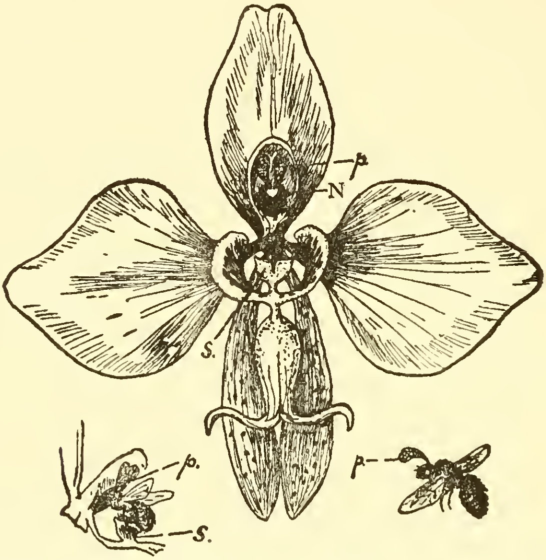

Fig. 14.—A Tropical Orchid. N, the entrance to the spur containing the nectary, in which the stigma is situated. Above N are the club-shaped pollinia (*pp*). The insect alights on the stool (*s*), and thrusts its head into the orifice. Touching the triggers (*t*), it releases the pollinia (*pp*), which spring off on to its head and there adhere. As the insect flies away they fall forwards, striking the stigma of the next flower visited

strike at the insect, like delicate mechanical hammers, until the visitor is completely dusted with pollen.

Other flowers emit whole clouds of pollen as soon as an insect approaches them. The Posequeriae are Brazilian plants, and among them is the "Araçá do brejo." The flowers are like those of the honeysuckle; they are white, and fragrant, and adapted for fertilization by insects with long trunks. The anthers are emptied into the flower, where the pollen adheres into a ball. If a butterfly touches the flower, this ball flies between the filaments, which spring asunder, and strikes the proboscis, to which it clings; at the same time the tubular part of the corolla closes, so that the butterfly cannot introduce its proboscis. If it wishes to quench its thirst it must go to another flower which has been visited some hours previously; here the way will be open to the nectary; the butterfly can insert its proboscis, and in doing so it rubs the ball off on to the stigma. In this ingenious manner self-fertilization is avoided. There are Orchids too which have catapult devices, and one species (Catasetum) can shoot its pollinia to a distance of a yard when touched. One can imagine with what violence they strike the head of an insect!

We cannot in these pages examine these miracles of Nature more thoroughly; they are so various and complex that Darwin was able to write a whole volume on the fertilization of the Orchids. But there are two mutual relations of which I must say something, for they represent the highest point of the co-operation of flowers and insects, and concern groups of plants of which many are native in Brazil.

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A family of plants which is distributed throughout the tropics is that of the Fig-trees, of which the South European Fig and the Indian Rubber-tree, a favourite indoor plant, are familiar to Europeans. Everyone has eaten a fig, but few will have examined the succulent fruit more closely, and discovered that the fig is a composite fruit, quite different in its structure from a pear. If we cut a fig in half we see that it contains a hollow space, and that this hollow is lined with a vast number of tiny fruits. The fig, indeed, may be compared to an urn. Before the fruit is formed there lie, at the bottom of the urn, countless little stigmas, whose pistils peep out like so many threads, and near the narrow mouth are tiny stamens with their pollen (Fig. 15). Into this urn creep little wasps, members of the Gall-wasp family, which by means of their stings create galls on the leaves and shoots, in which their eggs develop into larvae in safety, provided with an abundant supply of food, finally developing into wasps. The little Fig-wasp perforates one of the tiny ovaries with her ovipositor, and lays her egg in it. From this egg emerges the white legless grub or larva, and after gradually devouring the whole contents, it pupates in the ovary. The first to emerge from the pupae are the males, which, being wingless, look like small ants. They seek the winged females, which await them inside their galls, and fertilize them. Now the females too emerge, creep up to the edge of the urn, dust themselves over with the pollen of the stamens, crawl through the opening to the light of day, and wander off to another fig, which is younger, so that its ovaries are still intact. Here they at once lay their eggs, perforating the ovaries, and in doing so rub the pollen all over the stigmas. The ovaries in which the eggs are laid do not develop, but the plant is indemnified, since enough ovaries are left which are not perforated, but are fertilized with pollen, so that they are able to develop into fruits. The fig-trees therefore develop their fruits under conditions of special security, for in the urn these are protected from the rain as surely as in a room. For that matter, the Mediterranean fig produces two kinds of ovaries: some with long pistils, which are intended for fertilization, and some with short pistils, which are utilized for the production of galls; annexes, as it were, placed at the disposal of their guests. So far, nearly fifty species of Gall-wasp have been discovered living in symbiosis with the 600 species of fig-tree.

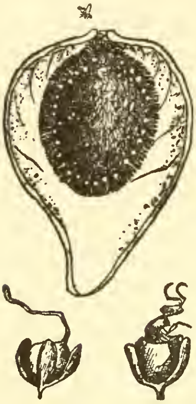


FIG. 15.—A fig, in section, showing the interior of the urn with the galls of the Gall-wasps, one of which is flying over it, while below, on the right, another (enlarged) is emerging from its gall. On the left is a single flower with threadlike pistil. (*Enlarged, after Kerner Hansen*)

Still more wonderful, perhaps, is the behaviour of the Palm-lilies or Yuccas. These plants belong to the Liliaceae, and are relatives of the Dragon-trees of the Old World. The inflorescence of the Palm-lily rises from a thick bush of sharp-pointed leaves; it consists of hundreds of handsome white bell-flowers, hanging like the bells of a glockenspiel. As the white or faint rose-pink of the flowers indicates, they are nocturnal blooms, and in the evening they burst open and shine through the dusk. If one examines them closely one sees that the inflorescence is surrounded by swarms of tiny white moths, which in the moonlight have a metallic lustre. For a while they dance their fandango in silence; then a female flutters aside and creeps into a flower. Here, with a sickle-shaped scraper, created only for this purpose, she sweeps the pollen together, and flies off to another flower, holding the mass of pollen, which is often three times the size of her head. Now we see that this little creature is equipped with an ovipositor, a most unusual organ in the order of the Lepidoptera. This ovipositor, which is infinitely slender, but none the less hollow, is thrust into the ovary, and an egg is laid at the side of one of the seed-capsules. Once her work is done the moth crawls up the pistil and thrusts the pollen which she has brought into the stigma (Fig. 16).

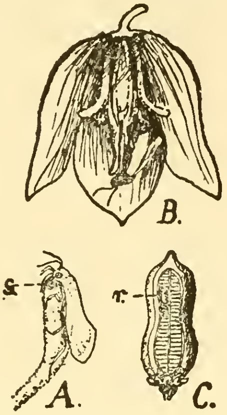


Fig. 16.—The Yucca-moth is shown at A sweeping up the pollen from a stamen, *s*; in B she is thrusting it into the stigma of a Yucca blossom, after laying an egg in the ovary, which is seen surrounded by stamens. C shows a section of the ovary, with the caterpillar lying amidst the seeds. (*Adapted from Riley*)

Now the work is done, and the little moth leaves the flower. From the egg emerges a caterpillar, which devours the seeds in the ovary until it is mature, when it gnaws its way out, lets itself down from the flower by a thread from its spinnerets, and pupates in a cocoon. But as soon as the flowers of the Palm-lily bloom again the little moth emerges. In the meantime her old dwelling has not done so badly, for a single flower produces 200 seeds, while the caterpillar eats only eighteen to twenty, so that even if several eggs have been laid in the ovary enough remain to propagate the plant. The moth, of course, pushes the pollen into the stigma simply in order that the seed shall be fertilized and develop, and so provide food for the caterpillar, for unless fertilized the ovary would wither. But the plants profit by the moth's exertions, for without these moths the Yuccas, whose home is in Central America, cannot reproduce themselves. The finest form, however, the splendid Gloria, can be reared only from shoots, since the seeds never develop, because (or so it is presumed) its special moth is extinct.

It is difficult to imagine a more astonishing spectacle than that of this little moth, which, in conveying the pollen to the stigma, is apparently as conscious of her purpose as any gardener. And yet the whole action is instinctive. For who could teach the moth what to do? She has no example set her; she has never seen such a thing as a Palm-lily when she emerges from the cocoon; yet she flies to this plant, and no other, in order to perform her complicated task for the first and only time in her life.

Truly, this behaviour shows us that so far from the moth reflecting and acting deliberately, she is merely an unconscious instrument, and has no conception of the meaning of her actions. But not only is her instinct orientated toward this particular flower; her body too, with its pollen-scraper and ovipositor, is constructed for co-operation with the Palm-lily, and the plant itself has adapted its flowers to this very insect.

The moth has long been dead when the caterpillar emerges; she never sees the result of her labours. She should teach us, then, that the events of our lives, and the deeds and destinies of peoples, though to us they often seem aimless and void of meaning, may yet have come to pass as they should for the great Becoming. From the smallest moth to man himself, all things sow the seed of that which is to be, and which will come to pass even as Necessity decrees.

XIV

THE SYMPHONY OF VOICES

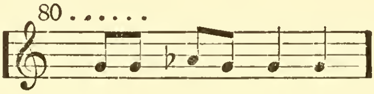
FROM the pealing of thunder to the quiet rippling of the brook, the tones of Nature are the expression of her mood. When we lie at the edge of the forest, when all is so still within us that our souls are conscious of the life and growth of the plants, and when the setting sun gilds the wide landscape, and behind us, from the darkling thicket, the evening song of a bird rings out, our eyes and ears admit us to a great Unity, of which we also, in happy self-oblivion, form a part.

It may be said that the voice of every bird is subtly attuned to its surroundings. The notes of the birds that sing by day in the sunlit forest are fresh and radiant; the bird that bids farewell to the setting sun has notes of passionate melancholy; and the call of the owl, as it echoes through woods at night, is dark with their own mystery. The trills of the lark are as endless as the heavenly blue in which it floats; the confidences of the reed-warblers remind one of the rustling of the reeds amidst which they sing, and the whisper of the gravel in the swift places of the stream.

So each part of the earth has precisely the bird-voices that are in tune with it, and those who seek to naturalize foreign birds in their own country betray a complete incomprehension of the harmonious art of Nature. And Nature revenges herself for such discords in her symphony; for every creature torn from its natural surroundings changes its habits and becomes a pest. In Australia, for example, the European starling has become a fruit-eater, and the Indian starling an egg-stealer; the larks there feed on turnip-seed, the greenfinches on corn, and to-day the Australians would gladly be rid of these unwelcome guests. But this is not so easy; it may even be utterly impossible; as it would be to exterminate the sparrow which has naturalized itself in North America, spreading from New York to San Francisco, to the despair of the farmers.

When first I arrived in Rio it was raining. I was rowed ashore to the quay from the coastal steamer by which I had come, and when I landed and walked into the city across a great open *praça* I felt as though I had left sunny Brazil, and was now in a seaport of Northern Europe. The rain was beating down the smoke of the chimneys, and all the air smelt of it, and on every side the sparrows chirped from the trees and housetops!

The European starling has unfortunately naturalized itself not only in Rio, but also in Southern Brazil, Montevideo, Buenos Aires and Chile, and is everywhere a pest. In Rio a few pairs were released in the Park of the Republic, and they proceeded to spread over the country. Since the note of the starling is a discord in the symphony of Brazilian bird-song, it is all the more regrettable that this bird is gradually ousting the pretty native Bunting, the "Ticotico." But in the neighbourhood of Rio at all events this brown and white speckled bird with the yellow patch on the throat still outnumbers all other birds, and in November I heard its rather peevish little song on every side:



the bird bristling its crest as it sang. In Pernambuco the sparrow is replaced by a prettier bird, the "Canario." This little bird resembles the familiar canary in appearance, except that its yellow plumage is set off by an orange-red forehead. Whole flocks of these "canaries" descend upon the streets and meadows; in north-eastern Brazil the people say that they are increasing, since they are becoming more and more accustomed to man, and nest under the tiles of a roof, if a tile is loose, or under the gables. I cannot represent the song in musical notation, for it has no real pitch; it is simply a metallic, staccato *zip, zip, zip, zulip, zulip, zipzipzip.*

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When the rumour of man and his machines dies away, then the voice of Nature comes into its own. As in a concert the solo voices and choruses rise above the orchestral accompaniment, so in the symphony of Nature there is a leading melody, and an accompaniment which expresses the mood of the countryside. The instruments of the orchestra are the seething waves, the wind, the rain, the rustling leaves; the soloists and singers are the birds, frogs and insects; but even Nature does not bind herself to hard and fast rules, and the frogs and insects may often take over the accompaniment, which runs on indefatigably, sinking and swelling.

Like the scents and colours, the tones of Nature blend into a harmonious unity; every concert in the woods and fields utters the mood of the landscape. This harmony impresses itself on the mind, so that I often seem to hear again the tones once heard, and thereupon I see the image of the land in which I heard them. The glittering tropical landscape calls for another sort of concert than ours, just as the minuet belongs to the rococo period, the waltz to the Victorian era, and the fox-trot to our own days.

Even the ocean sings a different song, on the sunny coast of north-eastern Brazil, from the song of the Baltic amidst the Frisian Islands. Since in Brazil there is not a day without sunshine, and the landscape smiles through the hours, there are no storms on the coast of Pernambuco; with an eternal, gentle murmur the trade-wind rolls the billows shoreward, to break, loudly thundering, against the rocks and headlands of the coast, flinging their spray high into the air. Even more violently the ocean casts itself upon the rocky coastline of Rio; indeed, at certain times the tide flows so strongly into the bay that the rollers breaking on the stone breastwork of the splendid promenade fling themselves up to the height, not of the houses merely, but of the very steeples: a spectacle of startling grandeur, a further wonder of this incomparable capital.

In the mountains of Rio terrific thunderstorms develop, and the rain often falls in such masses that the water is knee-deep in the streets and the passengers in the electric trams cannot alight, but have to travel round for hours. In Pernambuco, on the other hand, while there are sometimes inundations, thunderstorms are very rare indeed, and once, during a storm which occurred when I was in Olinda, a tremendous clap of thunder was followed, as though by an echo, by the shrill shrieks of terrified women from all the houses of the town.

A tropical rainstorm is more like a waterfall than the showers we know in Europe, and a characteristic sound of the tropics is the shrill, hard patter of the rain on the tough foliage of the trees. This metallic tone, however, is as perfectly attuned to the glittering landscape as the gentle rustle of our Northern rain to the tender, transparent green of the leafage of our trees.

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The leaves and flowers of many tropical trees look as though stamped out of sheet metal and painted with glossy lacquers; the plumage of many birds glitters like bronze; and many insects have gold and silver blended with the colours of their bodies. To this external aspect of the tropical country the metallic voices of its singers are attuned. When I went to Ceylon I was struck by the metallic tone of the birds' voices. In a great Indian Silk-cotton tree, which had shed its leaves, but had replaced them by a glory of strawberry-red blossoms, large as tulips, an Indian starling sat, its strophes pealing through the glittering sunny landscape like the tones of a trumpet, incomparable in their richness and variety. This was the Indian counterpart of our blackbird in the blossoming cherry-tree!

The new arrival in Brazil is promptly greeted by the Bemtevi, a bird about the size of our shrike, with brown back and yellow breast, and one black and one white stripe on either side of the head, which also bears a yellow crest. The Bemtevi, and a smaller relative, which resembles it, and also the Siriri, belong to the Tyrant family. These powerful, vigorous birds do really rule the neighbourhood, as their name implies. They sit on a tall stump, or the topmost branch of a tree, the yellow breast visible at a great distance, catching insects on their easy, dashing flight, and pursuing every hawk or Anum with an impudent outcry. Nothing escapes them, and the call, which to a Brazilian ear is *Bemtevi*, "I see you plainly," fits the bird as do few birds' names. Beside *Bemtevi* the bird has another call, *piae*, and in both calls, which he sometimes combines in a cheery song, the *i* is long-drawn, with a nasal quality. This nasal accent is so genuinely Brazilian that in conversing with Brazilians I was constantly reminded of the Bemtevi, and often wondered whether the Bemtevi acquired its accent from the Brazilians, or they theirs from the characteristic Brazilian bird. At all events, the Portuguese language, as spoken in Brazil, is rather metallic in tone, and seems to fit the environment. It is very musical; and often, especially on the lips of young girls, it reminded me of the clarionet.

The metallic quality of the voices of the Brazilian fauna is exemplified by the fact that the Brazilians have given the name of Ferreiro, "the smith," to no less than three different creatures. First, to a snow-white bird the size of a thrush, whose skin-covered throat has a verdigris-green, metallic lustre, and which lives in the forests of the southern half of Brazil; while in the north-west it is represented by a relative, not unlike it, but having brown wings and black hair-like feathers on the throat. When these birds are vocal it sounds as though someone were hammering iron rails with all his might: *peng*, *peng*, *peng*, *peng*, *peng*; beginning with a few slow strokes, and rapidly increasing the tempo. It speaks well for the nervous systems of the Brazilians that they are fond of keeping the Ferreiro or Araponga as a cage bird, and hanging it outside their windows, so that one hears the "smith" streets away; while if one stands before the cage one's ears ring with the din.

The second "smith" is the Bundle-nest bird or Turucuhé; its tones are not like hammer-strokes, but may be compared with the sound of a knife-grinder at work. While the Turucuhé is a characteristic bird of the Sertão, whose grinding sound seems attuned to the spacious wilderness, a cinnamon-brown relative, the Curutiá, is common all over Brazil. This bird does not very often suspend its great "bundle-nest," but builds it in the branches of a bush (Plate 28, 19). Its call is a shrill, far-reaching *trrrrr* . . .; which reminds one of the sound of a toy watchman's rattle. On all the paths of the Tijuca one hears its warning, emphatic *tikju*, or a sharp *zrip*, and sees the lively, cinnamon-brown bird slipping excitedly through the bushes, in its movements reminding one of our hedge-sparrow. Once I saw a Curutiá wade some distance into a stream, catching water-insects. The Potter-bird, "João de barro," has also a trilling cry, or rather shriek, *trrr*, which it intersperses with single vigorously staccato notes.

The third Ferreiro is a frog. The call of this large brown batrachian sounds like the stroke of a hammer on a barrel, and it would be more fitly called the "Cooper." A related species, Hyla crepitans, which I heard in a pond near Victoria in Pernambuco from a moving train, deluded me into thinking that a railway worker was throwing rails on to a heap. Of the first of these hammering frogs I shall say something in the next chapter.

A characteristic sound of all tropical countries, and also of southern Europe, is the song of the Cicada (Plate 29, II, 6). The Brazilians call this insect the "Cigarra." Therefore, if one wants a cigar in Brazil, one must not ask for a "cigarra," or one might be offered one of these insects; the Brazilians call cigars *charutos*. The name "Cigarra" really fits the insect better than Cicada, as it is more suggestive of the whirring "song" of the insect.

As in the case of the birds, it is only the male that "sings"; a fact which inspired the Greek Xenarchos of Rhodes to exclaim: "Happily live the cicadas, for their wives are dumb." The vocal apparatus is in the abdomen, and consists of two stretched membranes, like drum-heads, which are vibrated by special muscles. The sound thus produced is amplified by the large resonating cavities in the body. The Cicadas, then, are drummers, whereas the Grasshoppers and Crickets are fiddlers, for they draw a toothed shank across the edge of the wing, or even rub the wings together.

The female Cicadas lay their eggs, by means of an ovipositor, in the bark of a tree. Small larvae emerge, fall to the ground, and there, with the help of special spade-like digging-legs, live a subterranean existence, feeding on the roots of plants (Plate 29, II, 7). They take their time about it, passing through several moults, for according to their species it may be anything up to seventeen years before they mature. The larva finally appears on the surface of the soil, climbs up a tree, and hooks itself fast; and then the last moult takes place. The skin of the back splits lengthwise, and the Cicada, henceforth a winged insect, lifts itself out, waits for its plump grey body—as thick as one's finger—to dry, and then flies off. The split skin, however, remains hanging on the tree, and gives rise to the legend, which one hears all over Brazil, that the "cigarras" shriek until they burst.

As a matter of fact, hardly any insect has a louder voice than the Cicada. I often sat in the garden, with my friends, taking part in a lively conversation, when there suddenly sounded, from the nearest tree-trunk, in rapid crescendo, the shrieks of the Cicadas, silencing us completely until they abruptly broke off. Nevertheless, I could not be vexed with the musicians; but only felt thankful that I was still alive to hear such tones of Nature's symphony. When a Cicada sings it is as though a siren began to rotate, ever more and more rapidly, until at last the shrill whistle rings out. Phonetically, one might perhaps represent it by *zi, zi, zi, zi, zizizirrrrr*. Some have voices which are deeper in pitch, and in the very large forms the siren first howls a bass note, gradually ascending the scale: *Uuuua, zi, zi, zi, zi, zi*. Sometimes there is even a pretty harmonizing third.

In Seringal, Pernambuco, I wandered into the forest late one afternoon, when the last rays of the sun were shining through the foliage, so that the leaves glistened and the tree-trunks glowed with a reddish light. And then, before I had gone very far, what a revelation of life broke upon me! It was a fortissimo concert of Cicadas, such as I had never before heard. Here one began with the *crescendo accelerando* of its drums; there another joined in, and suddenly a siren shrieked close to my ear. At the same time, at every moment one of the insects flew off, the long glassy wings dragging the heavy body through the air with a loud buzzing sound; on every side their wings were glittering as these living aeroplanes flew from tree to tree and settled, their heads, with the great eyes on either side, pointing downwards. It was a deafening din, and the whole forest seemed to vibrate; indeed, one finally seemed to feel a resonance in one's own body. And this filled one with a quite peculiar emotion;

one felt at last that one was oneself an instrument of Nature and her musicians.

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Among the widespread legends relating to the tropics is the oft-repeated statement that the tropical birds are beautiful to look at, but do not sing. But I had not been long in Ceylon before I had convinced myself that the Indian birds have the most glorious voices, and that their song is no whit inferior to that of the European birds in beauty and variety.

As regards Brazil, we have already seen that this country is part of a continent which must have been early cut off from the northern mainland, at a time when the final ramifications of the various orders of animals had not yet emerged. But the song-birds represent such a ramification; they are in a sense at the very summit of avian evolution, and many developments that are merely foreshadowed in other orders have first attained perfection in them. The birds, as flying animals, are adapted to the use of audible signals of recognition; many of them, too, are gregarious, and naturally call to one another, and so, in order to produce the requisite vocal modulations, a special apparatus has been evolved, which is found only in the birds. This apparatus is the inferior larnyx, or *syrinx*. Like other animals, including man, the birds have a larynx at the upper end of the windpipe, but they have also a second larynx where the windpipe divides into the two branches, or bronchi, which lead to the lungs. This inferior larynx or syrinx is the actual singing-organ, and the many small muscles which lie around it have made it a musical instrument of the highest quality. The families of birds in which the musculature of the larynx does not assume such a highly-evolved and symmetrical form are known as the *Clamatores*, the screamers.

Since India has always formed part of the northern mainland, that country could share in the general evolution of the song-birds, and the birds had only to adapt their song to the tropical landscape. In Brazil, on the other hand, the singing-birds did not evolve in touch with the true centre of development of this order. In Brazil, accordingly, they do not play the same part as in Europe and Asia, but the Clamatores are more strongly characteristic of the avian world of South America.

Nevertheless, we find in Brazil a few singing-birds which in bodily structure, as in the quality of their voices, correspond completely with those of the northern world, and we shall not be mistaken if we assume that they entered the country where the Isthmus of Panama united North and South America. This immigration did not take place so long ago that the song of the birds in question has had time to transform itself into a completely tropical song. It still sounds as it does in northern countries, but for this very reason is all the more impressive, poignant and melancholy, just as in music many effects are produced by flat discords.

For this reason, in the Brazilian psychology, nostalgia, expressed in Portuguese by the beautiful word *saudade*, is evoked above all by the song of the South American thrush, the Sabiá. It was in enforced exile that Gonçalves Diaz wrote his song of longing:

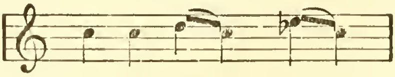
Our homeland has its palms,
There sings the Sabiá . . .

whose ever-recurring refrain is:

Where sings the Sabiá.

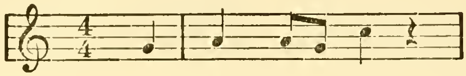
And no Brazilian poet who interprets the moods of Brazil will ignore this bird. I can well believe that a Brazilian in Europe is reminded, by the notes of our thrush, of the song of the Sabiá, and longs for the home which arises before him as he listens to its strains. I myself have experienced the converse. When in March I sat in the monastery garden in Pernambuco, and the song of the Sabiá rang from the forest, which was lit by the setting sun, the air was of almost unearthly limpidity, and the landscape was pregnant with a sweet melancholy. And then I thought of my home in a similar mood.

The Sabiá sings not only in the evening twilight, but also in the rain, sharing this peculiarity with our thrush and blackbird. In Pernambuco I heard principally two motives: *tüu*, *tüu*, *hüiüt*, *hüiüt*, quite like the motives of our song-thrush, but there were also warblers, which, like the blackbird, fluted more consecutively and had rolling notes. In the botanical gardens of Rio, which are swarming with Redbreast Sabiás, that go hopping all over the lawns, and sound a warning note like that of our blackbirds, and make the same din on retiring to their quarters for the night, I noted the strophe:

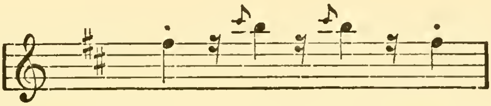


with a "dying fall" on the third and fifth notes. On the peak of

Tijuca, as the vast landscape of sea and mountain began to darken, a Sabiá sang, with infinite pathos:



This motive is like that employed by Carlos Gomes in the fine interlude of his opera *The Slave*, where the sunrise in Guanabara Bay is described in tones of music. There the Sabiá has the following melody:



Even outwardly the Sabiás resemble our thrushes, and the black Sabiá una looks exactly like our blackbird, and the Sabiá branco like our song-thrush, while the Sabiá larangeira is like a thrush, except that it has an orange-red breast. In Buenos Aires this latter Sabiá, there known as the Zorzal, was the bird most frequently seen in the park of Palermo.

There is yet another bird that looks as if it had just flown over from Europe. This is the Brazilian Hedge-sparrow, common all over the country, and known as the Carrixa (Plate 28, 7). In Pernambuco this bird is even called the Rouxinõl (the Nightingale), but this is to say too much for it, the song of the Carrixa being cheerful enough, but inconspicuous; it might be represented by *psip, zipzipzip ziplürrr*; but whatever its merits, it seems to give the artist much satisfaction, for the bird sings all the year round. In this it is like our hedge-sparrow, and distinguished from the latter only by its larger size and longer bill. The Carrixa, however, is no longer a woodland bird only; it prefers, like our European Redstart, to build its nest in odd corners, or on the joists under the roof of a house or verandah. There was a little bird at Olinda which had nested in the cloisters; every morning, cheerfully singing, it slipped into my room, and hunted for spiders in the corners and at the window, and it very soon discovered that even a naturalist may have his uses. On my table there were often lying all sorts of edible insects; once the bird pulled the pupae and larvae of a Urussú bee out of the comb, and cheerfully swallowed them.

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But Brazil has also her own song-birds, which have emerged only on the American continent. And above all, the Brazilian Starlings.

These represent, in America, the starlings of the Old World, but they have evolved along their own lines, producing forms, like the Japús, as big as a crow. Their plumage is most commonly a glossy black, whose dignity is enhanced by inlaid patches or stripes of red or yellow.

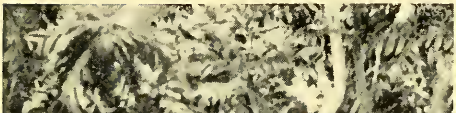
In the north of Brazil the stately Checheou is common: a bird beautifully marked with black and golden yellow, which in the south is replaced by the Melro, a smaller edition. The Checheou is a splendid mimic of other birds. He listens attentively to all that goes on around him, and then repeats it. I often amused myself by listening to a Checheou which sat in the boughs of a great Strangler-fig (Plate 18), whose large, glossy, cabbage-like leaves formed a fine background for the black and yellow of the bird. Sometimes the voice from the tree was like that of a ventriloquist; then it would utter all manner of possible and impossible sounds, interrupted by powerful flute-like notes.

The Checheou builds large bag-shaped nests, which it prefers to suspend from swaying twigs overhanging the water. It is fond also of building near a wasps' nest, as if any animal with an appetite for eggs approaches, it is driven off by the pugnacious bird with the help of the wasps, alarmed and irritated by its excited behaviour. The sorry defeat and retirement of monkeys who had intended to rob the Checheou has often been witnessed.

The big black Japús have similar habits to the Checheou's, except that they build their hanging nests in colonies. A bird widely famed as an excellent singer, and often kept in cages, is the Graúna. The Soffrer too, that handsome black and orange bird of the Sertão, is a good singer. I was less pleased by the voice of the Soldado, a black starling with scarlet shoulders. It was with wonder and admiration that I gazed (in March) at a flock of these birds disporting themselves in a meadow in Pernambuco. But when one of the cock birds began to sing it seemed at first that he could not quite manage to bring out his voice, until suddenly his efforts were crowned by two shrill major thirds. The beak of this bird is so powerful that when we caught one he struck it clean through the wooden bars of the cage.

Other Brazilian singers which have earned their name by their musical tones are the "Organists." In the forest of Alto da Serra I heard the Gurundi, a noble black bird with a red hood. The piping of the cock is like that of the Oriole: *tüiu tüiu tüulü diu tüulüdiu.* These birds are noticeable both for their plumage and for their excited

MANGO-TREE, SHOWING FRUIT, AND MACAIBA-PALMS



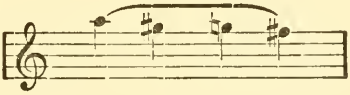
BREADFRUIT-TREE

JACA-TREE

manner of flying to and fro. The Gaturamo, with yellow breast and a yellow patch on the forehead, also belongs to this group. Unfortunately I never heard it sing, although a pair had built a nest on a palm-leaf in the monastery garden.

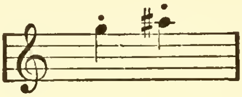
The olive-green Greenlets, and the Sanhaçus, of which I have already spoken, are singing-birds, and so are the delightful blue Sahys or Sugar-birds, which bear a resemblance to the Humming-birds (Plate 28). Of these birds the useful Sebito (which is not, however, blue) has been mentioned more than once. Its song is like that of the Goldfinch: *zip zip zip zip zip-pfüit.* Often one hears only the ringing finale.

There are singers of the highest rank among the Finches, and the Pintasilgo, a yellow Siskin with black head and wings, is often kept as a cage-bird for the sake of its song. There are in Brazil quite a number of different species of finch. They play an important part in the bird-life of the country, but are not easily seen, as they are given to settling on the meadows and picking the seed from the haulms of grasses, and on such occasions they alway join together in flocks. The Brazilians call the most numerous of these finches, a small grey bird with a black head and a black spot on its white throat, *Papa capim,* that is, "the Grass-eater," while another grey, white-bellied finch, which is distinguished by a strikingly massive pink beak, is known as the Redbeak. This bird has a penetrating plaintive call:



Another cries *Curio, curio* in a fine whistling tone; others sing a whole descending scale, like the European Wood-wren; and all these voices together swell to a delightful concert, which grows louder as the sun nears the horizon. In March, in the monastery garden, I heard this attractive music every evening; Nature was growing green after a long spell of drought; a cool breeze was springing up, and all things were refreshed by the spring-like atmosphere. With a light heart I strode through the prosperous landscape, and came to a standstill before a bush from which a gay finch-like song was ringing. High on the topmost twig sat the little "Caboclinho," the "Little Indian." This pretty finch has the complexion of an Indian, with dark wings and a dark cap, which looks like a head of hair. The song of this brown-headed bird is delightful; it begins with a lovely whistling tone, and is followed by notes of which all are sweetly melodious. The whole might be represented by: *hüi du pridu psid-pudilit prrr zip zilit.*

About the same time there sounded from the sugar-cane fields, in which a certain amount of grass was still growing, apparently from some invisible source beyond the hills, two notes which seemed a call: they were always the same, and were repeated again and again after brief intervals:



In the failing light, which seemed further to increase the spaciousness of the landscape, this call had an accent of grief. Wherever I went, even in my room, I still heard these two notes, like an admonishing *memento mori.* No one could tell me the name of the calling bird, and I never had a sight of it. At last the call seemed to sound from the next field of cane; I went toward it, but mysteriously enough the tones grew neither louder nor softer. For a long while I walked over the short grass towards the summit of the hill. Suddenly I saw the bird, and recognized a species of Cuckoo, speckled with brown, with a slightly curved bill and a long tail. Later I learned that this bird, because it incessantly utters these two notes, is known as "Sem fim" —"without end"—which words very fairly reproduce the sound of the call.

Thus, even among those Brazilian birds which have no actual song there are some with melodious voices. To reckon the Tovaca one of the Clamatores is really an undeserved insult. This bird, which is one of the Ant-birds, but looks like a short-tailed thrush, sings the chromatic scale in a quickly-whistled series of notes, which often pass through several octaves. I heard this melodious and most singular series of notes in Alto da Serra.

Melodious too is the *plück* of the Wagtails, which from a distance sounds like the dropping of water, and the Lavandeinas or "Washer-women" are constant inhabitants of the shore. The *a-nu* of the Anúms too rings prettily over the meadows. A larger species of Cuckoo, brown and yellow, a bird with a long tail, mews like a cat, and the Brazilians have therefore christened it "Alma do gato"—as though the soul of a departed cat had been reincarnated in the bird.

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No description of the voices of Brazil must omit the Frogs. Their concert is in many neighbourhoods as constant an accompaniment of all other sounds as is the seething of the sea along the shore. Brazil is the land of frogs, and almost half the species of the order live here. In the next chapter we shall see how variously these batrachians seek to adapt themselves to the conditions of life which their environment offers them.

In Brazil one can hardly say that the frogs croak. They bring forth every variety of tone: they roar, hammer, grunt, trill, rattle and whistle. In the rainy season in Pernambuco, during the months of the European summer, the frogs' concert is at its loudest. When in July I travelled from Recife to Olinda, on crossing the belt of mangrove-swamp I heard from every side a clear cool whistle, *hüut*, and I found this pretty and not too obtrusive music positively pleasing; it harmonized so perfectly with the landscape of bush and standing water with the open sea behind them. The Whistling Frog, a small species with a pointed nose, I was able to observe more closely on the monastery farm at Olinda. This frog lives in holes, and if of an evening one goes cautiously across a meadow one can often catch sight of him at the entrance to a mouse's hole, into which he shrinks back at once when aware of danger. Once, when a Whistling Frog was whistling merrily and indefatigably in a Pitanga bush, I crept quietly closer, imitating his whistle; he answered me every time, and we piped a lively duet. If I did not quite strike the pitch there was a deeper, rather hoarse answer, as though the frog were laughing at its unskilful mimic.

Another frog constantly uttered a cheery *Hoi*, *hoi*, so loudly, and with such a human accent, that I kept on thinking that this time I was really listening to a human voice. Sometimes too the call sounded like *Pfui*, and I was told in the monastery that a Brother who had newly arrived from Europe once decided, as he was feeling the heat excessively, to bathe in the stream that flows past the monastery farm. But when he had undressed he heard cries of *Pfui*, *pfui!* on every side, so that he hastily threw on some clothing and ran away!

In the straw of the thatched roofs lives the little Rattle-frog. Sitting on the verandah, one always hears its voice before rain falls; it sounds as if someone were rubbing two sticks together. Once I caught one of these frogs and took it to my room in a glass. It pressed itself so closely against the earth at the bottom of the glass that I could scarcely distinguish it; however, it took the first opportunity to run away. I looked for it in vain, and giving up the search, sat down at my table in order to work by lamplight, for it was evening. Scarcely had I begun to write when I suddenly saw the little creature sitting on the table, staring at the light with its great golden eyes.

As soon as it grew dark one heard, all over the monastery, a dull clucking sound; it seemed to come from the depths of a cellar, but as a matter of fact it was the voice of the Giant Toad, *Bufo maximus*, a huge batrachian almost as long as one's forearm, with handsome black or green markings on its back. Once, when I was bathing in a tree-shaded woodland brook, one of these creatures hopped into the water beside me. Despite all my love for animals, this proximity was too much for me, and I left the brook to the "Sapo." At one season of the year these huge toads may be seen hopping all over the streets, but I am glad to say that the Brazilians do not persecute this useful creature. When in danger this toad assumes a strange, intimidating attitude, with its head lowered and its body laterally dilated. A smaller species is found in all the ponds and lakes of Pernambuco in the month of March, when it creates such a din that one has to shout in order to make oneself understood. This frog has a trilling note, continued for several seconds; it sounds like the deafening rattle of an overloaded gear-wheel. As soon as one begins to trill another joins in; puffing out their laryngeal sacs, the toads hop splashing to and fro, and the pond seems to have been transformed into a true witches' cauldron.

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And this whole concert, from the voices of the birds to those of the frogs and insects, is the work of the male sex! Difficult though it may be to realize, since in our human world we are accustomed to the contrary, we must admit that the glories of Nature, so far as they are contributed by the animal species, are due to the male sex. In certain families of butterflies the males alone are perfumed, and they have even special brushes on their wings or bodies which scatter the liquid secretion of their scent-glands into the air; it is the males only that sing, quack and chirp; and as we see from the example of the cock, the peacock, the Bird of Paradise and other birds, even chromatic splendour is largely reserved for the male sex.

Of the reason for this partial distribution I have already spoken: we know that the female sex has no reason to complain of such injustice, but should rather be proud of the fact that her safety is set above that of the male, so that she commonly lives in concealment, and is rarely in the company of the male. For her inconspicuous colouring and modest voice are allotted to the female with a view to the task of incubation and the rearing of the young: a task which is essential to the preservation of the species, and which must be performed as inconspicuously as possible, lest the defenceless young should fall easy victims to the enemies of their kind. If the cock assists the female in this task, he is at once provided with protective colouring; on the other hand, if the young are reared in dark holes or burrows, the female too may wear conspicuous specific markings, and in such cases—as is demonstrated by the parrots—there is no difference in the voices of the two sexes.

In both sexes the voice, like the coloration, has evolved, in the first place, into a means of recognition. Every bird has its special calls of enticement and warning; and in the case of birds that live in societies these calls become more various, and develop into an actual language. The same thing is true of such mammals as the monkey, which lead an arboreal life not unlike that of the birds. But even the sound of the footsteps may be pressed into service as a signal of recognition; and if the experienced hunter can recognize his quarry by its approaching footsteps, it is only natural that the animals themselves should rely on such signs to a much greater extent. In the same way the birds may be recognized by the beat of their wings; the approaching Humming-bird is announced by the hum of its pinions, and many insects likewise have an audible flight; and in the Dragonflies the whirring of their glassy wings varies with every species. The Locustidae may be heard at a considerable distance as they fly, especially the gigantic locusts of Brazil; and there are some which as they fly make a curious clatter with their wings, like the red-and-blue-winged "Clubfoot" of the Alpine meadows.

In Brazil there are even "Rattle butterflies." Their wings are like black satin, with a pattern of blue spots, and a white stripe runs across each fore-wing. As a general thing they cling to the bark of trees, when their wings (contrary to the usual habit of butterflies) are outspread flat against the tree. If another of the same species approaches, the sitting butterfly flutters away, when one hears a perceptible clatter. Sometimes, too, these butterflies flutter round one another for quite a long time, clattering as they fly. Other Ageroniae have wings that seem covered with white lace. In March these were very common in Pernambuco. They contributed greatly to the beauty of the landscape, and supported the buzzing of the bumble-bees and the songs of the birds with a curious xylophonic accompaniment.

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But if the voices of birds and animals are intended to bring the sexes together, why do the birds continue to sing and the frogs to croak after they have found their mates? When a pair of birds have built their nest and laid their eggs, the cock bird still goes on singing, and yet there is now no question of the necessity of finding and recognizing one another.

Darwin, in his work on Sexual Selection, sought to explain this circumstance by the theory of selection by the female. According to this doctrine, the bird sings in order to arouse desire in his mate. Darwin, indeed, was even of the opinion that the voices of the birds had evolved into actual song because the hen birds have always listened most willingly to the best singers, as these excited them more effectively. Consequently the good singers found mates; they were the fathers of the next generation, which, since it was begotten by such fathers, must have possessed a similar gift of song. But of these the most gifted singers were once more chosen by the females; and so the vocal art improved from generation to generation.

Illuminating as this theory may sound, I have always had my doubts as to its value when I have listened to the birds singing in forest and meadow, and have watched them as they sang. For if the song of the cock bird is intended for the hen, one has at least the right to expect that the latter shall hear it! But more often than not she is nowhere to be seen; she is not concerned with the song of the cock, and never approaches in order to hear it better. A thrush may be fluting ever so bravely in a tree-top; the hen bird is never found sitting beside him, listening in rapture. If I have looked about for her I have generally found her on the ground, pulling an earthworm from the soil, or working at her nest. As for the cock, he does not seem in the very least degree anxious that the hen should admire his skill. If he were anxious to charm her by his song, he would at least approach her! But he prefers to sit in the tree-top, singing to the world at large, as though no hens existed! And every bird-fancier knows that if one puts a hen into the cage of a singing cock, the latter, so far from singing twice as well, as one would expect in the light of Darwin's theory, simply ceases to sing at all!

On the other hand, if one wishes a cock canary to do his best one must not give him a mate. But the presence of another cock will excite him to sing more vigorously! It is the same in a state of nature. If one hears a bird singing more loudly and beautifully than usual, one may be sure that one cock is singing against another; and only too often this competition ends in assault and battery. Similarly, the display of the peacock or turkey-cock, the dancing of the heath-cock or the orange-red Cock-of-the-Rock in the silent forests of the Amazon, are intended not for the hen, but for other cocks! They are not erotic dances, but expressions of jealousy and pugnacity!

And so with the song of the bird, the rutting call of the stag, the chirping of the cricket. Let us reflect that the conquest of the hen's affections is by no means the most difficult of arts! If she is in the right mood she cares nothing for beauty, or for skill in song or dance, but simply accepts any male bird that comes her way. Even in the case of our dogs we see that the shabbiest mongrel often finds favour with the most aristocratic bitch. The suitor's real difficulty is to get the better of his rivals. We must not forget that throughout the animal kingdom the males are in the majority, so that many of them can never succeed in propagating their kind. There is therefore competition between them, and indescribable excitement, and any means is good which will lead to victory. Even when the male has won a female he must not take things too quietly, for there are young bachelors in every thicket, always ready to take possession of the nearest female. For this reason the bird sings on the topmost bough; for this reason he makes himself as conspicuous as possible! He wishes to make his presence known, to make the quarrelsome bachelors conscious of his whereabouts. Many birds, like the little black Surador finches, which one sees alike in the capital and in the desert, fly upwards as they sing, to make themselves more conspicuous. And on observing song-birds of other species, in Brazil and in Europe, I have always been convinced that the singer was feeling the urge to make his presence known, in order to show that the female of his beat or district already had a mate, and must therefore be left alone. Such behaviour, then, amounts to a kind of intimidation of rival males. And the actual effect of the rutting-call of the six-pointer stag is that the younger stags timidly turn aside. Again, if he watches the behaviour of the turkey-cock, the unprejudiced observer must confess that the dance of this bird is more like a dance of rage, a war-dance, than a tender wooing. And human dances even, among the most primitive peoples, are danced only by men, and are war-dances, just as the most primitive form of music is the war-cry and its accompaniment; while the most primitive personal adornments were not intended to adorn—that is, to attract admirers—but to intimidate the enemy. With this end men let their hair and beards grow, wore the heads of animals above their own, and painted themselves in imitation of the wounds they had inflicted on their enemies.[1]

Of course, the animal does not purposely *intend* to intimidate his rivals by his behaviour. For the bird, singing is a necessity: at mating-time the blood runs more swiftly in the veins, and the overflowing energy of the body finds a vent through the larynx. Singing is the overflowing of intensified life, just as love is a doubled sense of life: both being an expression of that energy by means of which the living creature lives beyond itself and multiplies. But the effect of such behaviour is intimidation: that is, the thrusting aside of the weaker by the stronger, the mediocre by the gifted; and this entails a selection and the upward evolution of life.

But how could so uncreative and apparently negative an instinct as the instinct of intimidation give rise to such a wealth of tones, rhythms and colours? How comes it that we are attracted by what is really intended to terrify? Well, elsewhere we find Nature concerned with the formation of an invisible substance, and her efforts result in the supremest beauty. Think of the flowers, of whose splendour I spoke in my last chapter! What are they but the sexual organs of the plants? Can we imagine that the corresponding organs of the animals could ever have been transmuted into such miraculous forms?

Both facts teach us that however deeply we study the nature and the means of the evolution of our planet, we are studying only examples of behaviour; but we cannot comprehend the meaning of these examples, the ultimate Power that lies behind them, because we ourselves are the object of its activity. And we shall regard this Power with all the more reverence when we perceive how it contrives to unfold its eternal beauty even when working with the most unpromising material. After all, what is matter, what are stones, water, the earth? How swiftly beauty departs from the body doomed to decay! Matter and spirit are eternal opposites: for which reason all the religions and philosophies have sought in the liberation from matter the liberation from suffering, inextricably wedded to matter. The flowers may exist for the propagation of the plants, the song of the bird may assure it of the possession of its mate, and of undisturbed increase; yet in all these things there lies a deeper activity, for which all evolution signifies only a portion of the journey. And although we cannot perceive and understand this activity, we can feel it. And to feel it is truly to comprehend the beauty of Nature, and to attune our souls to her most intimate harmonies. So we ourselves become instruments that play their part in the great symphony, to our own supremest joy.

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[1] For further details as to the doctrine of intimidation, see my book, *Das Tierleben unserer Heimat*, Freiburg i. Br., F. E. Fehsenfeld, 1922–23.

XV

CAREFUL MOTHERS

A MOTHER nurses her ailing child without complaining of the extra burden. She treats it as a matter of course; she enters the sick-room cheerfully, and so becomes a very sun of healing; and we are filled with reverence before this revelation of the selfless feminine soul.

Throughout all Nature we find the selfless care of the mother for the child. Even among the animals we perceive, on every hand, the self-sacrifice of maternal love. And we shall not despise this instinct in the animals, disposing of it, perhaps, with the disdainful remark that such care is merely an inevitable instinct, devoid of understanding. Even the human mother's love and forethought are not inspired by her understanding. She loves her child without considering why she does so. Love enters her heart when the child is born; and even so this love is an emanation from the great Becoming, no less than the wonderful things which we see the humblest living creature accomplish for the sake of its brood.

In Recife, where I lived in a *pension*, I used to sit on the back verandah of the airy, open, palm-encircled house; and I used to like sitting there after the others had gone, in order to delight my eyes with the sight of the fascinating little guest who regularly visited the supper-table (Plate 30). Like a kitten he emerged from between the palm-leaves, with his woolly grey coat and his thick black-and-white barred tail; so like a kitten that his gnome-like face, with its round eyes attentively fixed on the observer, was all the more surprising. Then, with a leap, the Saguim monkey sat on a post of the verandah railing; a second leap, and he was on the table, reaching for the remains of the fruit that lay there. And now a mother monkey came swinging along the electric lead that ran under the verandah roof; she had a baby with her, anxiously clinging to her back: an enchanting little creature, no bigger than a mouse. Soon she too was on the table, and now, before anything else, the baby's coat was given a thorough cleansing. The mother gave particular attention to the proper arrangement of the coiffure; for while she herself wore her hair parted, with two white tufts, right and left, the baby wore his hair brushed smoothly over his forehead, and extending down to his neck, as many young people like to wear it to-day. The baby felt at home at once, and made himself busy about the table, putting the castor-sugar into his mouth and coughing it out in all directions, which seemed to amuse him greatly. For a long while I watched the little creature with such feelings as the Brobdignagian ladies may have entertained at their first sight of Gulliver.

The care of the simian mother for her child has long been a matter of comment; indeed, in German the fondness of a doting parent is described as *Affenliebe*, "monkey-love." But we use the term to denote an exaggerated and over-indulgent affection. There is no place for such affection in the relation of the simian mother and child, for, as Brehm has observed, the monkey child follows its mother so instantly and unconditionally that many a human child might profit by its example. But the intensity of the simian mother's self-sacrificing love may be judged from a story which Schomburgh tells of a South American Capucin monkey:

"I was about to return to my boat, when the anxious voice of a monkey in a tree overhead informed me loudly that his mother had forgotten him in her wild flight. One of my Indians climbed the tree. Scarcely had the monkey seen the unfamiliar figure, when in his terror he emitted a few loud cries, which were instantly answered, from the next tree, by the returning mother. No sooner did the terrified animal hear these tones than he replied at the top of his voice, and was once more answered by the call-notes of the mother. The poor thing was fired upon and wounded; she turned to fly, but returned again instantly when her darling once more uttered his notes of alarm, and with an effort she leapt, disregarding a second shot, which missed her, on to the bough which bore the complaining youngster. She quickly took him on her back, and was about to make off with him when, against my strict orders, a third shot killed her. Even in her death-struggle she held her darling fast, and attempted to escape, but in so doing fell to the ground."

The Brazilian deer too are careful of their young. In the case of the small red Brocket, the "Veado," which does not assemble in herds, both parents, united in faithful matrimony, protect the calf, hide it in the bushes in case of danger, and show themselves to the enemy, in order to divert his attention to themselves. A pair of Pampas deer once pursued a traveller who had found a calf, and taken it with him, for half an hour. The pugnacious Peccaries are well able to defend their young, and it is said of the female Anta, or Tapir, that she will place her calf between her legs and defend it to the last. The carnivora too are indefatigable in their care of their young.

Among the birds, the Parrots should win our respect and liking by the affection which they show to their mates. As Brehm observed, these birds live in strict monogamy all their lives, and the two sexes love one another deeply and faithfully. At pairing-time their dependence on one another is intensified; everything they do is done in common; they snuggle close together and overwhelm one another with tender attentions. If either bird is shot the survivor does not fly away, but falls a victim to its loyalty. Azara tells of a Macaw that followed the body of its mate, who had been shot and tied to a saddle, into the middle of a town; when the dead bird was placed on the ground the living bird fell upon it. For several days the faithful creature remained beside the body, until at last it was caught by hand. So profound is the Parrot's grief and longing for its dead mate that its whole body trembles, and it pines away and dies. In such cases Hebbel's words are the sober truth: the bird does not feel grief, but *is* grief.

The young birds are included in this mutual love; the whole family live only for one another, and the parents will defend their young to the death. It is a striking characteristic of the Parrots, that their need of loving is so great that in the absence of their own kind they will extend their affection to quite alien species of animals, and even to the human beings who tend them. This is especially the case if a bird or animal has an accident and is crippled; so that not only love but compassion is natural to these birds.

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Birds and mammals occupy a special position in the animal kingdom in respect of their forethought for their young. They live to see their offspring born and grow up, and the latter are followed by their parents until they can go their own way. In all the rest of the animal kingdom, as we shall see, it is only by exception that the parents and their offspring have any knowledge of one another. The rule is, that when the parents do evince care for their offspring, they show not solicitude but forethought. The mother makes such dispositions on laying her eggs that her offspring, when they emerge, will find food and shelter provided for them; after so doing she leaves the spot, and as a rule has long been dead when the eggs are hatched and the young make their appearance.

In the case of such actions we can no longer speak of parental or maternal love; for love must be given to a creature which is seen. Such an animal as I have described cannot know the meaning of its actions, since it does not live to see their result. These actions are performed without understanding, and unconsciously; they are the operation of an urge which enters the insect's body at the breeding-season. And its body is already organized to fulfil this urge, so that the whole seems to us like a fully-wound train of clockwork, which suddenly begins to run down when the urge releases the stored energy. We call such behaviour *instinctive.* This instinct is bestowed upon the living creature just as its body is bestowed upon it; it evolves with that body, and is bequeathed by the parent to the offspring, and neither the one nor the other can vary it in any direction. In just the same way we receive, together with our eyelids, the faculty of closing them in a flash if the eye is imperilled. If we ask whence this instinct comes, we find this inquiry included in the greater question: who was finally responsible for setting the evolution of life at work upon the earth, and in the last or first resort, for the emergence of the worlds themselves? For instinct, in unbroken continuity, runs through the whole of evolution.

Whereas instinct is inborn, the operations of the understanding first come into being in the lifetime of its possessor; and while instinct does its work without model or example, and under a given internal compulsion, the achievements of the understanding are bettered by learning and practice. Every silkworm, however carefully you may isolate it from its kind, spins its cocoon in precisely the right manner. But no child will ever learn to write unless its teacher shows it how to do so, and unless by practice it gradually acquires the power of controlling its pen-strokes with certainty.

Therefore those animals in whose lives intelligent action plays a part have need of a season of learning and of practice, a protected period, during which their lives will not be imperilled by every unsuccessful attempt. Such a season is enjoyed by the mammals and the birds; it is the period of youth. In its youth the kitten learns to catch mice; the young falcons learn to stoop and seize the prey which their parents let fall as they swoop overhead. If they miss it, they are in no danger of starving, for the old birds catch the victim anew, and the game is played over again. It was for the sake of such "child's play" that the protected season of youth was established; in its youth the young bird or mammal exercises its bodily and mental faculties, which it inherits in the germ, but which are not yet fully developed.

But it is not granted to the lower animals to learn under the supervision of their parents. The secure and joyous time of childhood is shared only by the birds and mammals. Other creatures, if they survive to see the emergence of their brood, do no more than watch over them and protect them. What the young are able to do they do not learn; their ability develops of itself. While a young fox-cub does not yet know his enemies, every lizard, as soon as it creeps out of the egg, avoids larger animals, while it seizes smaller creatures and swallows them; but no one has ever taught it to do so.

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One of the most fascinating chapters of the animal life in Brazil is that relating to the parental instincts of the Frogs. We have already seen that the frogs are abundantly represented in Brazil; of the 150 species of Tree-frog—and this is the group which is distinguished by the variety of means by which the brood is protected—no less than 75 are peculiar to the moist forests of Brazil.

I shall never forget a frog-hunting expedition which I undertook in company with Dr. Lutz, who knows more about frogs than anyone in South America.

It was the 7th of January. After a pleasant supper-party at the doctor's house we set out on our expedition, accompanied by my host's daughter—herself a naturalist—and the servant, the negro Joaquim. The electric tramway took us to an outlying quarter of the city, at the edge of which the hills rose against the sky. The night was pitch dark, but we lit our lanterns and went our way, while the whole landscape seemed to vibrate with the cries of the cicadas, and here and there a screech-owl made itself heard.

A heavy odour of earth and decaying vegetation rose from the ground; the foliage of the bushes, and here and there the great leaves of bananas, gleamed as the light of our lanterns fell on them. Now we came to the hedge of a nursery-garden, and suddenly a strange music sounded in our ears. It was as though hundreds of hammers were violently and indefatigably striking an empty cask. As we entered the garden the sound ceased. We flashed our lanterns on the ground, and suddenly the great eyes of the Hammer-frog glittered in the light, the white above the pupils gleaming like an opal. These great batrachians, which the Brazilians call "Smiths" or Ferreiros, and which belong to the family of Tree-frogs, have brown bodies, and balls on their finger-tips, with which they cling to the foliage of the trees as though by means of india-rubber suckers.

We now saw why they had left their secure habitation. The Hammer-frogs were constructing their nurseries! In the large muddy pool in which they sat they had built circular walls, about a foot in diameter and high enough to rise out of the water. These walls were built by the female frog, who brought the mud required in her fingers, piled it up, and smoothed the interior most carefully with hands, belly and throat, in doing all of which she had to bear the weight of the male, who sat upon her back, in order to fertilize the eggs as soon as these were laid in the crater-like structure. In such fortresses the little frogs wake to life; they are at first, of course, long-tailed tadpoles; then their legs develop, while their tails are absorbed. This nursery fortress protects them from enemies of the piscine race, and alterations of the level of the surrounding water leave them unaffected.

We went on. A *grä, grä* greeted our ears, like the voice of the German Tree-frog, and already Joaquim had caught the green singer among the reeds. He resembled our Tree-frog, but was larger and bonnier. Now we heard a delicate *srip, srip, srip* from the reeds, as though a chicken had strayed thither. This was the voice of the tiny Pigmy Frog, and he too was soon detected by Joaquim's sharp eyes. We caught also a large brown "Eyed Whistler," whose voice is like the chuckle of rising air-bubbles; and at the end of our rounds, by the edge of the road, where the water had overflowed the gutter and wetted the stones of the causeway, we found a pretty little Slender Tree-frog, whose brown body bore spots of sealing-wax red on the loins. It uttered a long, complaining, or rather mewing *oak!* and we found its eggs, imbedded in foam, which surrounded the clutch like the dough of a doughnut.

Like the Slender Tree-frog, the "Eyed Whistler," which owes that singular name to the fact that it has black eye-like spots on its body, and belongs to the Whistling Frogs, buries its eggs in a foam-like mass; and so does the Whistling Frog described in the previous chapter. Most of these frogs dig holes in the dry ground, into which they eject the eggs and their foamy covering. The advantages of such a method are obvious. On land there are no predatory fish and aquatic insects, and under their coating of foam even terrestrial animals do not recognize the eggs as being edible; moreover, the coating protects them from desiccation. As a rule the eggs are produced shortly before the beginning of the rainy season, and are so timed that soon after they are laid the water of the neighbouring pond rises, inundates the land, and washes away the tadpoles, which have already hatched in their foamy bed, but are already mobile, and able to wriggle quickly away from their enemies.

In Petropolis a small brown green-speckled frog with an orange patch on its back was very common; wherever a brook ran over the rocks one heard its faint, clicking voice, like the stroke of a tiny hammer on metal. This Petropolis frog was not easy to detect, as its colouring resembled that of the moss on the stones, and it squeezed itself flat upon the latter, while extending its legs. It lays its eggs on the leaves overhanging a brook; when the tadpoles creep out of the eggs and begin to wriggle their tails, the surrounding foam is liquefied, and they drop into the brook, where one finds them writhing like snakes between the stones, hardly covered by the water.

Other creatures too remove their eggs, which as nourishing and tasty titbits are relished by many creatures, from the dangerous neighbourhood of the water. In Pernambuco and Parahyba I was enchanted by the handsome bunches of orange-red eggs, as big as peas, which I found everywhere in the thickets overhanging the tanks and ponds, sometimes surrounding a pond as with a necklace of coral beads, which was visible at some distance. These were the eggs of the Brazilian Operculate Snail, a large mollusc, whose shell is not unlike that of the European Vineyard Snail, but can be closed by means of a lid, which enables the inmates to sleep for years without danger of desiccation. This snail, which commonly lives in the water, and breathes through gills, has also a pulmonary cavity which is filled with air; and this air is supplied to the body through a conduit, the edges of the body folding over to form a tube.

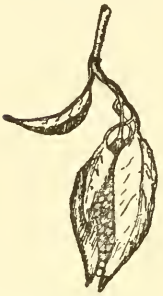

FIG. 17.—Leaves glued together by a Cat-frog (Phyllomedusa Iheringi) and containing the eggs

But to return to our Frogs! The Cat-frogs are pretty green Tree-frogs, the pupils of whose eyes are vertical slits, as in the cat. These frogs also hang their eggs over the water. Male and female climb into a tree, pull down a hanging leaf, and while with their hind-feet they press the edges of the leaf together the female lays her eggs in the tube so formed, and the male immediately fertilizes them. The glutinous jelly surrounding the eggs holds the edges of the leaf together. Another species of Cat-frog glues several leaves round the clutch, forming a regular bag, which hangs over the water, and from which the tadpoles fall when they leave the eggs (Fig. 17).

In the virgin forest of Pará Goeldi observed a Tree-frog which

CASTOR-OIL PLANT AT THE EDGE OF THE FOREST

SUGAR-CANE, TAPÉRA, PERNAMBUCO

we might call the Resin-frog. This remarkable creature is said to line a hole in a tree with resin, and lay its eggs in this watertight basin, which is filled by the next shower of rain. But recently doubts have been expressed as to whether it is really the frog that conveys the resin to the hole.

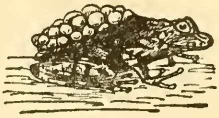
Fig. 18.—Goeldi Frog with a pocket of eggs on her back. (*After Boulenger*)

While the frogs hitherto enumerated do no more than provide their young with a safe home, and then trouble no further about them, there are frogs in Northern Brazil which lay their eggs in drying sloughs or puddles, and after the tadpoles are hatched they squat down in the puddle, when, with the help of their tails, the tadpoles are able to climb on to their backs, where they adhere by suction. Now, burdened with twelve to eighteen tadpoles, the parent frog wanders off in search of a larger puddle, to which she confides her offspring. These frogs, which are often handsomely marked in black and grey or black and red, are known as Tree-climbers, although they spend most of their time on the ground.

That these remarkable methods of caring for their young are innate is shown by other frogs, which have even been provided with special organs for the better safeguarding of their young. In the so-called Purse Frogs the male arranges the eggs on the back of the female, and here they remain, according to their species, either until they hatch, or until the female deposits them in the water.

In order to ensure that the eggs shall remain where they are placed, one species of frog, the Goeldi, has developed a fold of skin surrounding the back, forming a sort of dish (Fig. 18), while in another species this fold of skin so completely overgrows the eggs that they lie concealed in a sort of rucksack, where they are provided with oxygen by special and peculiar respiratory organs (Fig. 19). When they are fully developed the skin of the back splits (and what with her split skin, and the eggs underlying it, the female has a monstrous appearance), and the brood falls out.

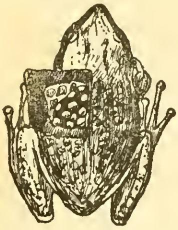
Fig. 19.—The Purse Frog, the skin of whose back covers the eggs. (*A portion is cut and turned back*)

In the northern part of the South American continent lives a toad which is known as the Pipa. It is an aquatic species. This reptile is calculated to increase the aversion which many people feel for the toad; for the whole of its back is as though eaten through, perforated like a honeycomb, and from the cells tiny legs are protruded: a truly uncanny spectacle. But this only increases its interest for the naturalist. When the breeding-season approaches the cells begin to form on the back of the female, finally assuming the form of little basins. Now the male climbs on to her back, and the female thrusts her long everted intestine, which is at the same time an oviduct, between their two bodies. The pressure exerted by the male forces the eggs out, when they fall into the cells, which have special self-closing covers. In due time the developing larvae burst the covers, and at first each protrudes a long tail, which seems to serve as a respiratory organ, and later on its legs, after which they forsake their hospitable parent.

With a glance at Chile, where the "Nosed Frog" swallows the eggs, which develop in the throat-pouch of the male, compressing the poor creature's stomach so that he is at last unable to eat, until his offspring relieve him by jumping out of his mouth, we will pass on to another subject.

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It is a strange fact that all the stages which we have rehearsed in describing the parental care of the Frogs are repeated in the case of the Fish. But among them we observe an even subtler elaboration of the problem to be solved.

A whole family of fishes hatch their eggs in their mouths. Of this family we find in Brazil a whole series of handsome and savoury fresh-water fishes, such as the Acarás, the Joanninhas of southern Brazil, and the Tucunarés of the north. Some of these fish lay their eggs in any suitable place, and by fanning them with their fins provide a constant supply of fresh, oxygenated water. When the young fish are hatched they take them into their mouths and spit them out into carefully prepared hollows; and they then continue to watch over them until the little creatures are able to swim.

The smaller species of this family are favourite aquarium-fish, and it is delightful to see the father, surrounded by his offspring, take them into his mouth at a threat of danger. For in these species it is usually the father who fosters the young; the mother is often such an unnatural parent that the father has to be constantly on his guard lest she should devour her eggs or the young fry!

But there are fish of this family which actually incubate their eggs in their mouths; and in these species it is usually the female to which this task is allotted. In such fish the head absolutely bulges with all the eggs in the pharynx. Matters are even worse when the lively little creatures are hatched; the parent fish finds it so difficult to breathe that she has to shift her brood to and fro in her mouth, as we shift a mouthful of water when rinsing the mouth. When the young fry are able to swim the mother blows them out, but in moments of danger they instantly gather about her head; she opens her jaws, and all the little fishes, often to the number of fifty or sixty, slip through the open door. Later, as they grow more venturesome, she has to swim after her brood, in order to collect them in the evening and protect them from the perils of the night.

In the rivers of southern Brazil there is a great Silurid or Cat-fish, locally known as the Bagre. The male fish takes the large eggs into his mouth (they measure as much as a twelfth of an inch in diameter), when the self-sacrificing creature is no longer able to eat; so that dead fish have often been found with their mouths full of dead fry.

The Nandidae show peculiar devotion to their eggs. The female, with her long ovipositor, fastens the eggs in some convenient spot; the male, paddling with his fins, provides them with fresh water; but first any mud there may be is cleared away from underneath, lest the little fish, when they are hatched, should fall into it and be stifled. Certain Plated Catfish make a proper nest of grass-stalks, with an opening into the interior, and the Scaly Salamander-fish or Lung-fish (Lepidosiren), in Brazilian the Pira m'boia, but known as the Lolach in the interior (Fig. 20), digs holes a foot deep in the bottom of the Amazon and its tributaries, which are reached by a horizontal passage often a yard in length. Here the eggs are laid, and the male fish watches them, and in order that he may breathe more readily he has developed tufted outgrowths on his fins. The Lung-fish is eel-like in form, but it already represents a transition to the Batrachians, for its swimming-bladder has begun to transform itself into a lung, and enables the fish to take in air at the surface of the water. If the stream dries up this lung-bladder enables the fish to survive buried in the mud.

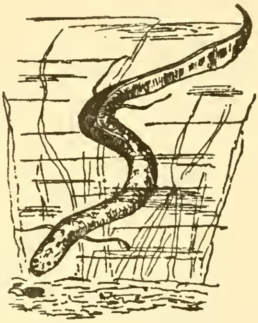

FIG. 20.—Salamander-fish, Lepidosiren (*greatly reduced*)

Finally, there are fish which remove their eggs from the perils of the pond or river, and hang them over the surface. In an aquarium the male Pyrrhulina may be seen rising, with his mate, to the top of the tank, when both fish leap into the air, and remain clinging to the glass above the surface of the water. When they fall back we see that ten or fifteen eggs are adhering to the glass, being held there by a mass of transparent slime. Now the male stations himself beneath the eggs, and every half hour or so he sprinkles them with his tail-fin.

Like the Pipa, the Flat-headed Catfish (Fig. 21) carries its eggs upon its body. It first lays them on the river-bed, and then rubs them with its belly, which is covered with cup-shaped cells, and in these the eggs are caught and held fast. It seems that in this species the eggs are actually nourished by the blood of the parent; a state of things reminiscent of the mammals.

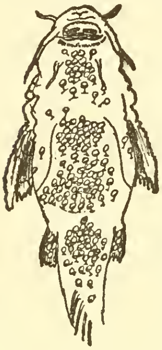

Fig. 21.—Flat-headed Catfish (Aspredo laevis) with eggs on belly. (*After Wymann, reduced*)

In the case of the Fishes, as in that of the Frogs, we are able to verify the principle stated in Chapter X: namely, that equilibrium is maintained either by increased fertility or by greater security. The further parental care is developed, the better it assures the survival of eggs and young, and the fewer eggs are required to secure the continuance of the species. We see, accordingly, that when there is greater parental care the number of the eggs is diminished, while the size of the individual increases. If the Pyrrhulina lays 150 eggs, the "Mouth-hatchers" 60, and those Catfish which guard their brood still fewer, while the Carp lays 500,000, the Halibut 3,000,000, and the Cod 9,000,000, these enormously disparate figures show how finely Nature can adjust the coefficient of increase, and how, when it is necessary to cover the monstrous losses of a species unremittingly persecuted, from the egg to the adult form, she takes no account of numbers.

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A stupendous variety of devices for ensuring the survival of the young, and a steady gradation, from the most inconsiderable to the most ingenious achievements, are to be found in the insect kingdom. These matters must awake interest in even the most sophisticated, and since the insects are the most numerous of all the living creatures, we have here a province by which anyone may approach the study of natural history, and constantly avoid the danger of boredom. For example, the inhabitant of Rio might go to Alto Boa Vista one fine summer morning, and wander along the footpath to the peak of Tijuca; or he might cross the Bay, and stroll up the hills of the

Sacco São Francisco. The Paulista might start on his excursion from Ypiranga or S. Anna, and the inhabitant of Recife from the fine park of Dois Irmãos, going through the woods to Macacos station; while the Bahian has the coastal landscape at his disposal. Such a budding naturalist will wander slowly on his way. He will examine the path he is treading, and stand still if a bee flies out of a little hole in the ground; he will take note of the nature of the burden with which it returns, and will excavate other holes, to find larvae of singular form lying in wait for their prey. On the leaves of the bushes there is much to be seen, particularly on the underside. He should hold an open umbrella under a bush and beat the boughs with a stick, and examine all the creatures that fall into this receptacle. If he closely examines the bark of a tree, he will find insects whose bodies so exactly imitate the markings of the bark that a passing glance would never detect them. Lastly, it is a fascinating pastime to lift the stones at the bottom of a brook, and examine their undersides, and brush off the little worms and insect larvae adhering to them into a glass jar.

How richly rewarded, how full of interest, one returns from such an excursion! Even if the man of business has but a few hours in the evenings at his disposal, he can still occupy himself with the things to be seen, and endeavour to understand their meaning. May this book help him to do so! for then all that he has learned will order itself into a harmonious whole, and this alone is an enduring gain. Such knowledge brings the learner, step by step, to a higher plane; he will rise higher and higher above the commonplace of everyday life; the harmony of Nature will enter into his personality, and he will be freer and happier.

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We will now begin our study of the means which the insects take to ensure the survival of their brood, and we will begin with the simplest forms; though it must be confessed at once that the laying of eggs is never a matter of complete simplicity. To begin with, there is the instinct which always impels the insect to lay its eggs where the emerging larvae can find their food, quite apart from the devices which are intended to protect the eggs, such as laying them on the underside of leaves, where their enemies are not so likely to see them, or closely adhering to the midrib, or even piled up into little pointed heaps so that they look like the buds or shoots of the plant on which they are laid.

Many insects lay their eggs on the plants on which they themselves live. The Plant-lice, which suck the sweet sap of leaves, multiply on these same leaves; and it does not strike us as wonderful that a Leaf-bug should lay its eggs on the food-plant which is its own source of nourishment. But we may find in Brazil very remarkable dwelling-places, and eggs laid in most peculiar positions. One of the most curious dwelling-places is that of the Sloth-moth. The Sloth moves so slowly that an insect has selected it as its dwelling-place, just as though it were a stuffed example in a museum. One may imagine the surprise of the explorer who first shot a sloth and saw a whole swarm of little moths fly out of its fur! We do not even yet know whether the caterpillars live on the hair, like those of our Clothes-moths, or whether they eat the green algae, the microscopic plants, which often grow so abundantly on the fur of the Sloth that its whole coat assumes a greenish hue.

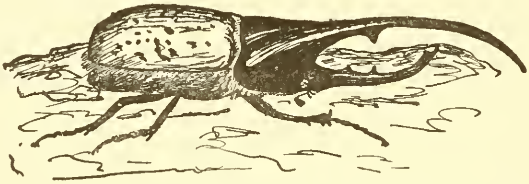

FIG. 22.—Hercules Beetle (*half life-size*)

The beetles that feed upon wood have a more troublesome task; here the female insect must bore a special hole for the eggs, or she may have to dig her own way into a rotting tree-trunk, even though her own diet may consist of leaves. The giants among the beetles of Brazil live in the timber as larvae, where they become so thick and fat that the Indians and negroes roast or fry the white grubs, which are as big as a man's finger, and eat them with relish. One of these beetles is the Hercules (Fig. 22). The male has handsome grey wing-covers, and from the scutum a long curved horn or tusk runs forwards, which is opposed by a toothed horn that grows out of the head, so that the two make an unsymmetrical pair of tongs. With this horn the beetle is six inches in length. What are we to make of these singular sham tongs? Are they intended to imitate a real pair of pincers, and to serve as a means of intimidation? But then, as in the case of the deer, this intimidation would come into play only in the contests of the males, for the much smaller female wears no horns, and looks merely like a gigantic dung-beetle.

With such ornamental antlers she could never bore her way into decaying wood.

Not less huge than the Hercules are the black Actaeon and the white and green dappled Elephant-beetle; and here again the males are provided with great horns. In the case of another species, the mighty Strategus, a Rhinoceros-beetle, the larvae find their way from the soil to the roots and the base of the stem of young coconut-palms, and destroy them. Among the Weevils even there is a large black beetle, the Palm-weevil (Plate 29, II, 10). The female bores a hole in a coconut-palm and lays her egg in it, and the larva, when it emerges, excavates the interior of the stem, and finally pupates in a cocoon woven of bast-fibres. And the Perandra (Plate 29, II, 9) actually fells trees as thick as one's arm, in order to lay its eggs in them when they begin to decay.

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Even greater riddles are presented by the egg-laying of insects when the adult has no dealings with the food-plant of the larvae. How does the butterfly know that she must lay her eggs on the leaves of this or that bush, when she herself lives only on the nectar of flowers, so that leaves mean nothing to her? It is easy to suggest that as the eggs ripen in her body she remembers her infancy, when the leaves were her own food, but to do so is to be guilty of an unjustifiable anthropomorphism. What can we human beings know of the mnemonic powers of an insect!

Moreover, there are accessory circumstances which cannot possibly be explained by memory. The butterfly, for instance, cannot remember that as an egg she adhered to the underside of a leaf, for an egg sees and feels nothing. Yet every butterfly affixes her eggs precisely as is proper for an insect of her species. And are we to credit an insect with not only the memory of past events, but also with prophetic foresight? How otherwise do the caterpillars of the Silk-moths come to spin themselves a silken house, a cocoon, in which to pupate? They cannot know that on their next moult they will become immobile pupae, needing no food, but in special need of shelter and protection, since they cannot flee their enemies! As a matter of fact, such a caterpillar needs to look even further ahead; it must know that when the skin of the pupa splits open a winged creature will appear, which will have to escape from the cocoon, for the silkworm leaves an opening as it spins its house, protected by bristles as the opening of an eel-trap is guarded by withies, so that while the moth can bend them aside as she creeps out of the cocoon, no enemy can force its way in.

On the leaves of the Orange-tree graze the caterpillars of the handsome black Idaeus, whose hind-wings are decorated with spots of strawberry red. On pupating, the larva of this butterfly grasps a twig with its hind-claspers, leaving its body sloping upwards and standing away from the twig; at the same time it spins a thread which lies like a sling round its body and the supporting twig, so that the pupa looks like a lateral shoot. Since the caterpillar binds itself on to the twig before it pupates, it must know what its girth will be when a pupa, and what position the pupa will assume, for it has to calculate the length of the thread accordingly. We cannot in this case speak of intelligent action, since there is no one in the world about the caterpillar from whom it could learn its art. The larva goes through the whole skilful performance once and once only, without example and without practice, and yet with infallible success.

The insect's technical instructions are therefore contained in the unconscious; they develop with the insect's body, and at the right moment find expression in action. The insect is driven by an urge so powerful that even deadly danger will not prevent it from accomplishing its work. As a Dragonfly darts to and fro above the pond, choosing its prey, it takes good care not to fall into the water, for there it would drown, since it can breathe only in the air. But when the breeding-season comes the male and female of at least one species clasp one another and climb down a reed and under the surface, in order to make little incisions on the stem of the reed, and lay an egg in each. For the larvae of these insects live on the floor of the pond, as predatory creatures, and they are provided with gills.

In the southern portion of the South American continent there is a Swimming Weevil (Hydrotimes natans), which goes under water only at the mating season, in order to lay its eggs. There are, moreover, Mayflies, Caddis-flies and other insects which spend their youth in the water, while this element is fatal to the adult insects, and is carefully avoided. But the urge of procreation forces them to imperil themselves.

Love changes a human being, and turns his soul, according to the nature and the object of that love, to good or to evil. And the animal also, when seized by the procreative urge, often becomes a different creature. There are insects which normally are harmless vegetarians, but when the egg-laying season approaches they become ferocious beasts of prey. It is, of course, only for the sake of their young that they turn to a predatory way of life, since their offspring live on animal food alone, while their parents cannot share their gory meals.

In this respect again we may perceive, in the insect kingdom, a series of evolutionary stages. There are small insects called Mantis-flies which trap their prey; they look like little Mantises, and like the latter they catch small insects in the gins formed by their folded forelegs. In these species both adults and larvae are flesh-eaters. For the tiny larvae which emerge from the eggs try to get into the egg-sac of a Wolf-spider: which entails long effort and a protracted fast. The female Wolf-spider, of course, always carries the sac about with her. At last, however, the larva is successful; it bores its way through the wall of the sac, and feeds on the yolky eggs, while the spider notices nothing. The unsuspecting mother now guards and protects the murderers of her offspring as though she were still carrying her own eggs. In Brazil there are species of Mantisidae in which the female, provided with an ovipositor, lays her eggs in the cells of a wasps' nest; in this case the larvae feed on the eggs and the stores of their involuntary hosts.

The history of the Ant-wasps (Mutillae) resembles that of the insects which I have been describing. The males are not unlike other wasps; one finds them on flowers, whose nectar they suck. The females, however, have quite a different appearance; they are like ants, and are wingless, and crawl about on the ground. The body is hirsute, and has a satiny gloss; it is often finely marked with black and red or yellow. The females too are vegetarian, but when they wish to lay their eggs they creep underground in pursuit of living insects. It is to fit themselves for this underground adventure that they have lost their wings; and their likeness to the ants may serve as a protection. Some species lay their eggs on the brood-cells of Bumble-bees, and the emerging larvae feed upon the rightful occupants of the cells.

The female Ant-wasps chirp like crickets, thanks to the special formation of the edges of the abdominal segments, which they rub together. Perhaps they are able by this means to attract the attention of the flying males. In the case of the Thynnus, which has a similar appearance, the union of the sexes has been observed. To the observer, the procedure had the appearance of an abduction. The male fell upon the female, embraced her with tender passion, and flew off with her. The distribution of the species is enlarged by such nuptial flights, for it would be a long while before the earth-bound female could conquer new territory.

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The Ichneumon-wasps are pretty little insects, very active, and always whisking their antennae up and down. They may often be seen on leaves or flowers on which Plant-lice (Aphides) have scattered their saccharine excretions, so that the whole leaf or petal is sticky and shiny. There the female Ichneumons seek their food, and the males, as long as they live, never do more than lead a harmless existence among the flowers. Not so the females. Their forethought for their brood makes executioners of them.

A caterpillar is peacefully nibbling at a leaf. Suddenly it starts; a tiny black wasp has flashed past its head. It returns, and desperately the caterpillar lashes out at the enemy against whom its instinct warns it. Many caterpillars even eject long jets of fluid from their mouths, which are intended to intimidate the aggressor. But nothing is of any avail; suddenly the little wasp has seized her opportunity; she alights on the caterpillar, and plunges her ovipositor into its flesh (Fig. 23). In most cases this happens before the caterpillar can defend itself, for the Ichneumons fly silently; they do not hum.

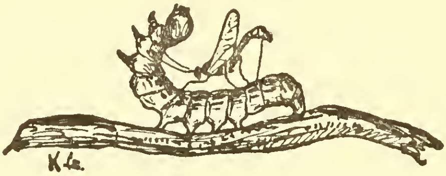

Fig. 23.—Ichneumon on Caterpillar

By means of her tubular ovipositor the Ichneumon has thrust one or more eggs into the caterpillar's body. The caterpillar quiets down again, and pursues the only occupation of which it has any knowledge, that of eating. But after awhile a larva emerges from the egg in its body; in appearance a tiny maggot. And now it begins to eat. But it does not simply devour whatever is beneath its mandibles, for then it might sever some important nerve, and the caterpillar would die. The whole object of laying the egg in the living caterpillar is to ensure that the larva shall have fresh meat until the time of its pupation. The insects cannot, like the foxes or wolves, continually obtain fresh prey for their young; as a rule their lives are too short to permit of their surviving until their eggs are hatched. Nature has therefore devised a way out of the difficulty; the mother must not kill her prey, but must see to it that her larva can live on the victim, on emerging from the egg, without being endangered by it. She therefore sinks her ovipositor into a living caterpillar, and the larva, hatching out inside the caterpillar's body, eats first the fat and flesh, and respects the vital organs. The caterpillar lives on, and passes through various moults, and only just before pupation does it collapse, an empty skin. But now the larvae have completed their development, and can pupate in their cocoons beside the husks of their victims.

I made the acquaintance of several of the Ichneumon-wasps of Brazil while I was breeding the Rosy Caterpillar; and it occurred to me to note which species of this most dreaded enemy of the caterpillars had already adapted itself to the Cotton-grubs, in order that I might inquire how the multiplication of these Ichneumons could be assisted. In my gauze-covered breeding cages some tiny black Ichneumons crept out from among the caterpillars, and also a larger species with a striped abdomen. There are Ichneumons of various forms and sizes in Brazil, and according to the nature of their victims, their ovipositors are longer or shorter. Many species have an ovipositor the length of one's finger, and these have usually adapted themselves to the exploitation of larvae which live in wood. We can only wonder how the Ichneumon contrives to locate her victim through the thickness of the wood, and by means of her thread-like ovipositor to bore through the bark and wood with such accuracy that it enters the caterpillar's gallery just at the right spot, and sinks into the body.

The Bronze Wasps also provide their larvae with living nourishment: these are the insects whose bronze-green, red and blue body-colouring delights the lover of Nature in Brazil. These wasps fasten their eggs to their victim; the emerging grubs then bore their way into the caterpillar.

The same end—namely, the provision of fresh meat for the brood—is attained by another race of insects by other means. While the Ichneumons carry their eggs to their victims, the Hunting-wasps carry their prey to their eggs, which are usually laid in burrows. In order that the victim shall not die and dry up or putrefy before the larva emerges, only a little poison is introduced by the sting, so that the creature does not die, but lives on paralysed. Incapable of escaping, or of defending itself, or of doing more than feebly twitch its limbs, it has perforce to submit to be slowly eaten alive, in a dark underground burrow, by the offspring of its enemy. And these larvae display the caution of a torturer; they eat only those parts of their victim's body whose destruction will not be fatal.

In Brazil, soon after my arrival, my attention was attracted by a black wasp (Plate 29, II, 14), compared with which our Hornet is a mere pigmy. With silent flight it cleaves the air with its dark, white-mottled wings, apparently trailing behind it a long ovipositor; but I soon realized that the insect was flying with its hind pair of legs outstretched. I never succeeded in capturing such a "Cavallo do cãe" (Dog-horse); its flight was so swift and sure that my net was never in time.

Only in the Sertão did I at last obtain a "Dog-horse"; on approaching a flowering tree in the bush, I saw several of these insects circling round it, settling on the blossoms, and drinking the nectar. It was a pretty spectacle: the flowering tree, with the great black wasps steadily and silently circling round it.

In a chink high up in the corner of two walls a Bird-spider had spun its lair, a sort of white hammock—I had often watched it at work—and there waited for the night, before setting forth on its predatory excursions. It fell upon insects of every kind, and even frogs, for this great spider, which is as large as a freshwater crayfish, but looks even larger, with its black furry body and long hairy legs, can overcome creatures of a respectable size.

Suddenly the resting spider shrank into itself: the black hornet, its most terrible enemy, had made its appearance. Once more the insect flew past, but now it descended from overhead, threatening the spider's back. Quick as lightning the latter stood up on its four hinder legs, and struck at the enemy with its hairy forelegs. Beneath its head I could see the long daggers of the mandibles, surrounded by fiery red hair, as though dripping with the blood of their last meal; standing high on its legs, the venomous creature was a horrible and startling spectacle. But the hornet did not allow itself to be intimidated; swifter and swifter, coming now from the right, now from the left, it flew past its intended victim. Suddenly the spider struck out too violently; it fell forwards, and before it could stand erect again the black enemy was seated on its back, thrusting its poignard upwards into the nerve-centres.

Paralysed, the spider collapsed; it was helpless; it could do no more than feebly twitch its legs, while the victor flung it down from its hammock, seized it anew on the ground, and walking backwards with long, elastic strides, dragged its victim after it. The journey was a long one. Often the hornet released its hold, and ran quickly forwards, but it always returned and dragged the spider a little further. At last the goal was reached: a hole leading down into the earth. The hornet hurried into the burrow, saw that all was in order, and dragged the spider after it. While so doing it was very much on the alert. On another occasion I watched a hornet attempting to drag a spider into its burrow. Something, apparently, was not as it should be; and as the hornet quickly ran back into the hole, I looked more closely at the spider, and turned it over, but restored it again to its proper position. The hornet appeared again, and dragged the spider into the hole. I had intended to await any further proceedings, but was called away, and when half an hour later I returned to the hole, hornet and spider had disappeared, and in the burrow itself, which I excavated, there was nothing to be seen. The hole was not deep, and was wide at the surface.

In this burrow the hornet lays its eggs on the body of its victim, closes the entrance, and leaves the spot, in order to lay a second egg in the same manner. After some days the larva creeps out of the egg, and begins to eat the spider. The living meal lasts until the larva has passed through all its moults and is ready to pupate.

Bates has a story of another hornet. The explorer had just landed on a sandbank in the Amazon, in order to cook his mid-day meal, when suddenly a wasp or hornet swooped on to his neck like a stooping hawk. He started back, but he really had reason to thank the hornet, since it had just espied a horse-fly or Mutúca, which had settled on Bates's neck in order to suck his blood. The blood-sucker was seized, and the hornet flew off, tenderly pressing its booty to its breast.

While most of the hornets excavate burrows in the earth in which their larvae can mature, or make use of the deserted holes of frogs or mice, the Potter-wasps or Mud-wasps make nests of clay, which take the form of large grey balls, and hang from the twigs like fruit. Inside these balls are the cells for the eggs and their food-supply, mostly spiders. On the walls of the monastery at Monte in Olinda I found clay tubes assembled in the form of panpipes, with a pleasing diagonal stripe across them. The interior of each tube was partitioned off, and contained an oval capsule of horny consistency. This enclosed the larva, with its paralysed booty. Some bees too, however, had made use of this structure, having built themselves cells in a few deserted tubes, and in each cell they had placed an egg and some honey.

Anyone who has ever observed a hornet at work—and to watch the large, handsome "Cavallo do cãe" is truly such a treat as only Brazil can offer—will always receive the impression that the insect is acting with the most subtle consideration. And yet the insect never sees the result of all its labours, never learns that one day a larva, which needs fresh food, creeps out of the apparently lifeless egg; so that an innate instinct alone can tell the insect what to do. It cannot be guided by recollections of its own youth, for the larva was not in existence when its mother fell upon her prey, and she herself never saw, nor has the newly emerged hornet seen, how the victim should be overpowered, and where the sting should be inserted in order to paralyse it. And yet at the very first attempt the hornet strikes accurately at the nerve-centre, which in the spider lies in the thorax, and, what is more, on the underside of the thorax. Hornets which seek other prey seem in each case to understand the anatomy of their victim; in the first place, they select only such flies, beetles, grasshoppers, etc., as have a readily accessible nerve-centre, and secondly, they understand in each case precisely where the sting should be inserted; and in each species of wasp or hornet the length of the sting is precisely that best adapted to the anatomy of its victim.

Again, the larvae know nothing of the significance of the various viscera of their victims, though they are careful to respect the vital organs. They too have no example to follow, no teacher; the instinct is inborn, and precisely because their behaviour is instinctive it works with absolute reliability.

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Certain of the Hornets supply their brood with small insects, such as beetles and flies, and a number of these would have to be brought to the nest and stored there, since a single victim would not suffice to nourish the larva. So here we see the beginning of another method, which resembles that followed by the birds and mammals. The mother does not die after laying the eggs, but survives until her larvae are fully developed, so that she can at any time enter their nursery, in order to see that all is well with them, and bring them fresh food.

Here, then, even among the insects, like a groping ray of sunshine, we see the first attempts at a common life of parents and offspring.

Among the Dung-beetles of Brazil there are magnificent species, as large as a five-shilling piece, gleaming red or blue, or even with a red, metallic lustre. The head of the Sword-beetle (Phanaeus ensifer) is adorned with a curving horn. These beetles are relatives of the Scarabaei, which were revered by the ancient Egyptians, and of which images in stone or pottery were buried with the dead. The Brazilian Dung-beetles excavate an underground gallery, and into this they carry dung with their outstretched forelegs, which are shovel-shaped, and toothed at the edge. This dung they knead into a ball, and at one point they pull the ball out a little, and in this part they imbed the egg, so that the air may have better access to it. In order to prevent the ball from drying, it is enclosed in a thick shell of clay, the whole being some two inches in diameter. But over the egg, in order that the air may reach it, the clay covering is left porous. Lastly, the way to the outer world is shown by morsels of dung left lying at regular intervals, so that the beetle which results from the larva—which feeds on the ball of dung until pupation—can at once find its way to the outer world, much as Hansel and Gretel found their way home.

Many of these Dung-beetles still go on working when the larvae have already emerged and are eating, while certain Rhinoceros-beetles even survive until the pupation of their offspring. It is the same with the Scarabaeidae. The female Bark-bug (Phloea corticaria), of which I have already spoken (Plate 29, 3), carries her whole family under her body, and according to Brehm it is even possible that the mother allows a portion of the sap which she sucks from her food-plant to trickle over the flat underside of her body, in order to nourish her brood.

In the case of the Green Cockroach which is common in Brazil it has been observed that the eggs develop in a brood-pouch on the mother's body, which the young leave only at a later stage. Among the Water-bugs there is actually a species in which the male is obliged to take charge of the brood, for the female simply glues the whole packet of eggs on his back. Brazil, like India, boasts of enormous aquatic bugs, which at night fly, with a terrific smack, against lamps and lanterns, but by day they rove about in the water, killing frogs or fishes with their venomous bite, and eating them.

Among the Sugar-beetles we find a real family life. These are long, flat, shining black beetles with ridged wing-covers, the largest of which grows to a length of nearly three inches. I found the Sugar-beetles in a rotten tree-trunk in Ceylon, and I met with them again in Brazil, where this family has attained its greatest development.

The Sugar-beetles are shy of the light, and live in the interior of decaying tree-trunks, where they are found in whole families, for since the larvae are no longer able to eat without assistance, the parents have to masticate the rotting wood and feed them; they also watch over the eggs. But since the family does not remain in one place, as it constantly eats its way forward through the wood, the two parents have to go first and clear the way, while the young follow. And just as our birds, wandering in the dark spring or autumn nights, continually call to one another, so the Sugar-beetles emit warning cries, lest their young should lose their way.[1] On the tip of the inner wing is a toothed plate, which is rubbed by a sort of bow on the last segment of the body, producing a shrill chirping sound, which may be so loud that Ohaus, who had placed a box containing a Sugar-beetle on his wash-stand, was unable to sleep for the truly infernal din of its constant chirping. The larvae too possess a chirping apparatus, but of another kind. Even when the larvae have pupated the parents remain protectively in their neighbourhood. The offspring enjoy this family existence for more than a year.

The life of the Sugar-beetle shows how little Nature is inclined to keep to a given scheme, and how, even in the insect world, she is able to devise relations which otherwise are found only in the higher orders of animals. The more profoundly we study the life of insects, the more vividly we realize that although the actions characteristic of the species as being necessary to their development are instinctive, many insects have the faculty of modifying their actions to meet altered circumstances, and of storing up experience, and profiting thereby. The insects are not machines which merely run down after being wound up. This will be shown in the next chapter, in which we shall see the fulfilment of many things which the insects hitherto described have but gropingly attempted.

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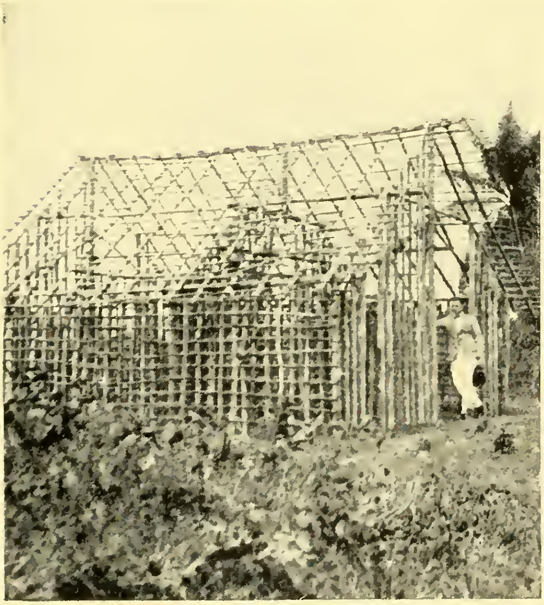
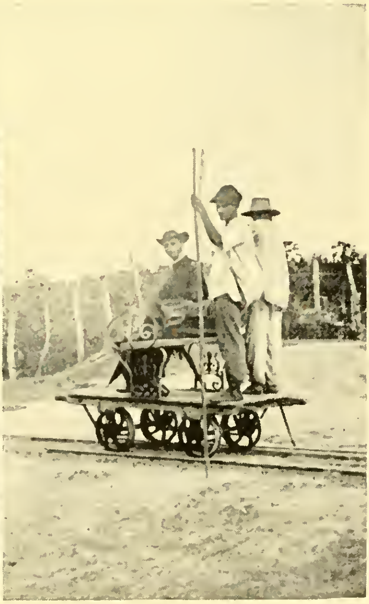
[1] According to the most recent observations, the larvae of the Sugar-beetle chirp only when they are disturbed, and are able to eat without assistance. When they approach one another too closely in the wood they chirp, and are thus able to keep their distance, and refrain from disturbing one another.

VIEW OF THE "PARROT'S BEAK," TIJUCA MOUNTAINS



BUILDING A NEGRO'S HOUSE



TRAVELLING BY TROLLEY

XVI

PIONEERS OF COMMUNAL LIFE: WASPS AND BEES

Creatures that by a rule in Nature teach
The art of order to a peopled kingdom. . . .

So Shakespeare calls the Bees, and we Germans have a name for them, *Immen*, which means "the diligent ones." And indeed, everyone who has ever glanced into a beehive must have marvelled at the delicate work performed there, and the diligence of the workers. Even from the outside, at the entrance to the hive, we perceive the signs of a busy and bustling life. Fresh bees are for ever creeping out, spreading their wings, and hurrying off with an assured flight, as though they had not the slightest doubt as to their destination. Others are returning from distant excursions and landing on the alighting-board, bearing visible signs of the success of their work, for the "bread-baskets" on their hindlegs are heavily laden with yellow pollen. And now bees appear at the entrance, emerging from the hive, which do not at once fly away; instead, they turn back, and for a time they fly to and fro in front of the hive, as though anxious to impress the details of their home on their memory. And as a matter of fact these are bees which, ever since they crept out of their chrysalids, have been constantly occupied in the hive, and are now, for the first time, about to go out into the wide world.

But who directs all this activity? Who tells these little creatures that it is now time to fly abroad: who tells these insects, which hitherto have never seen anything of the kind, where to find pollen and nectar, and how they should be collected? In a human community, as we know, there is no order where there is no government. Who gives the orders in the kingdom of the Bees, and who distributes the tasks?

Everyone knows that the community of the Bees has a "queen." But this name is really too pompous for the insect that bears it—namely, for the only fertile female in the hive. The "queen" is nothing more than a living egg-laying mechanism. She has no orders to give; indeed, even her own work of laying eggs is controlled by the workers, for these build the cells of the comb of their own initiative, in such numbers as are necessary for drones, workers, and other queens. The queen lays the necessary eggs in such cells as are offered to her, without expressing any will of her own.

The State of the Bees, then, is no monarchy, but a republic. Yet surely a republic, we ask, has need of a president, a leader and commander? From the very fact that in the insect State there are no superiors we perceive how fundamentally their organization must differ from that of the human State. Among the Bees and Ants no orders, no instructions are given, for every insect carries the law in its own breast, and any failure to observe it is simply impossible. The laws of the human State are devised by the subjects of the State; the new-born subject knows nothing of them to begin with, but has to learn them; each generation adds something to the rising structure, but what is bequeathed "must be acquired before it is possessed." With the limited discernment of the human mind, the individual enterprise will only approximately achieve its aim, since men differ so one from another that not all of them will understand it equally well. Many are not willing to adapt themselves to it, since they find it more agreeable to follow their own desires. And these have to be forced into the great framework by means of compulsion and punishment. But in the fact that work may constantly be done upon the ever-uncompleted structure lies the possibility of progress, and of the cultural evolution of the human race.

The insect State is not the work of its subjects, but of that Power which is responsible for the development of all terrestrial life. Every Bee, every Ant, bears within itself, at the moment of emerging from pupation, the whole cultural possession, so to speak, of the bygone generations of the State; this possession is inherited, in its full compass, with the details of its physical structure; and without needing to be taught, without displaying any reluctance, the insect enters into its service. But as Wasmann, the myrmecologist, has shown, the inhabitants of the insect State are by no means pure machines. They can store up experience, and profit thereby; but these possibilities of modification lie within the frame of their inborn faculties; for example, the Spider can make its web larger or smaller and anchor it in different ways, according to the space at its disposal, but it can spin only the web proper to its species, never the web of another species. The whole structure and all the laws of the insect State are "given" to the Ants and Bees; they cannot control its evolution. We must always be mindful of this fundamental difference in the nature of the insect State, and the forces that are at work in it, when we are tempted to attribute to insects relations and motives which exist only in the human community.

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As all things in Nature reveal the successive stages of a gradual evolution, we shall not at once find the insect community in its complete and perfect state. On the contrary, we shall find different stages of social life, leading up from crude beginnings to the subtly organized community of the Bees and Ants. The first condition of a community is that the mother shall live to see the larvae hatch from her eggs; the second, that the members of a species shall build their brood-cells close together, so that the instinct of *common* defence against danger is evolved. Thus, there are species of bees which build their brood-cells for themselves alone, and care for their larvae without assistance; but if anything disturbs even one of these insects, their angry humming infects the others. From all sides they fall upon the enemy, multiplying the efficacy of the onslaught.

The transition from the solitary to the social life is first seen among the Wasps. We have made the acquaintance of the Hornets, the Potter-wasps or Mud-wasps, and others; these are solitary as regards their provision for their brood, but even among them there are certain species whose activity does not cease with the preparation and provisioning of the brood-cells, for they continue to visit the cells when the larvae have emerged, and to bring them fresh supplies of food. In those wasps which fold their fore-wing when at rest—the Vespidae and the Eumenidae—these first steps are carried a little further. Among them the "Pill-wasps" still live a solitary life, but the true Wasps dwell in populous and well-organized communities.

In Brazil there are a great number of "Pill-wasps," with handsome black and yellow markings; the family may be recognized by the fact that the stalk by which the abdomen is attached is club-shaped, being dilated at its hinder extremity. They are called "Pill-wasps" because they make little spherical pots of clay, which in the smaller European species look like pills. In Brazil we frequently find such clay balls, prolonged at the top into short necks, and sealed, on walls and on various plants. If we open such a sealed jar we find inside paralysed insects, and the egg of the wasp, or even its larva, which has begun to devour its victims. Other species build larger pots, which may contain several cells in juxtaposition, so that the whole constitutes a sort of comb covered with a domed roof of clay. Among the enemies of the Pill-wasps are the Golden Wasps, small insects whose bodies have a green, blue and red metallic lustre; these insects wait cautiously until the Pill-wasp has flown away, when they crawl quickly into the pot, and lay their egg beside that of the rightful proprietor. The latter returns, takes no notice of the strange egg, completes the provisioning of the pot, and seals it up. The egg of the Golden Wasp is the first to hatch, and the emerging larva quietly devours the egg of the Pill-wasp and its intended victims.

There are Pill-wasps which do not seal their pots, but leave them open. These visit their larvae, and bring them fresh prey; indeed, many species even feed their larvae with masticated insects. Such care of the offspring is a step towards the community of the true Wasps. We have only to imagine that the mother-wasp begins to build whole rows of juxtaposed cells, so that she is still feeding the last larva to creep from the egg when the first of the family to emerge has already pupated, or has even become a wasp. In such a case it would hardly be an essential innovation were the young wasp to dedicate her activities to the common home, building her own cells beside it; or even were she to begin to feed the brood, her maternal instincts being aroused by the sight of the hungry larvae. We can very well imagine that by such premature demands on the maternal instinct the erotic urge which should normally precede this instinct, and ensure its development, is extinguished, so that the wasp now becomes a mere female helper in her mother's household. And now, if her sexual organs degenerate—as all things do degenerate which are not used—so that they *can* no longer be fecundated, the insect will become a *worker* pure and simple, and the mother, released from the labours of cell-building and feeding the larvae, and consequently able to devote herself entirely to the business of laying eggs, may now be called a "queen."

In the Field-wasps common in Europe and America—most of them barred with black and yellow—we find the early stage of such a communal State. The female masticates wood and similar substances, and produces a material not unlike blotting-paper, with which she at first constructs a short tube or brood-cell, adhering to a wall or the trunk of a tree. To this first short tube others are added, and the better to economize space the walls are flattened, so that the tubes become hexagonal; and so we have a comb, consisting entirely of cells hanging from a short stalk. In the American

Parasol-wasps, insects which have adopted the unusual habit of leading a nocturnal existence, a comb of this kind may be as much as 18 inches in diameter, and it hangs from the forest trees like a yellowish-grey parasol. At the bottom of each cell an egg is laid; from this a grub emerges, which hangs head downwards, and is fed by the mother with masticated insects. When the larvae have finished moulting they spin themselves cocoons, and each cell is given a lid, under which the inmate pupates. The emerging wasps help their mother, who may now be called a queen-wasp. It is true that they too lay eggs in newly-constructed cells, but since they are unfertilized only males emerge from them, for it is a law among the Wasps and Bees that unfertilized eggs produce males, and fertilized eggs females. When these males emerge they fertilize some of the females, and these found nests of their own, in which they become queens. In all the species of Field-wasp the State is founded by a single female, and with her death is ceases to exist. Even the European species of more highly evolved Wasps and Hornets build nests that last only a year. In the spring a fertilized female begins to build cells and lay eggs, until the first working females come to her assistance; in the autumn the community perishes, but a few fertilized females hibernate in dark corners, and the following spring each builds a new nest elsewhere. In sunny Brazil, a land of eternal summer, there is no need for this interruption of the communal life; there the conditions are favourable to the construction of large and durable nests, and so, according to Ducke, the basin of the Amazon is richer in wasps than any other region on earth. In the great wasps' nests of Brazil, such as those built by the Parasol-wasp, we find, accordingly, several fertilized females or queens, and the multiplication of communities is effected, as in the case of our Hive-bees, by the departure of swarms which construct a new nest, cell by cell, and enlarge it as their numbers increase, or first prepare the whole nest, and only then proceed to lay the eggs.

The nests show all the stages of increasing perfection. The Palm-wasps build comb over comb, connected by pillars of papier-maché, in the rolled-up leaves of palms or bananas. Still other wasps shelter their nests from the rain under large leaves, or even the roofs of houses. The "Pasteboard-wasps" have another method. These black insects, whose abdomens are adorned with yellow stripes, give their combs such a durable cover that they are able to hang their nest from the branch of a tall tree, where it looks like a huge, whitish-grey sausage (Fig. 24). Twenty or more combs may be superimposed, and their edges are so firmly knit into the cover that the wasps have to make special gangways in the combs in order that they may creep from one to the other. At the bottom the covering has a conical point, and at the vertex of the cone is the entrance to the nest.

The nest of another wasp looks like a Jaca-fruit (Fig. 24). This nest, as large as a man's head, is covered with spines, and presents a most uncanny appearance when seen amidst the boughs of a tree. As builders, the Wasps seem to learn from other creatures; at all events, they build a nest that is not too incongruous with their surroundings. Thus, Ducke saw some wasps' nests hanging amidst the bag-shaped nests of the Checheou, which had the same elongated form, while other nests, in the neighbourhood of spherical ants' nests, had assumed the same shape.

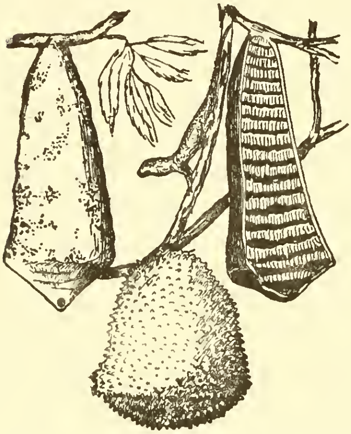

Fig. 24.—Left, nest of the Pasteboard-wasp, Chartergus chartarius. Right, the same cut open. Between them, a Keel-tailed Lizard. Below, a nest of Polybia scutellarius (*greatly reduced*)

The Wasps feed their offspring on the flesh of masticated insects, which they disgorge into the mouths of the larvae. The adult insects, however, are very fond of sweet food, as Europeans are only too well aware. In South America there are even Honey Wasps, which store up honey in the cells of their nests; and this honey is eaten by human beings, although while certain poisonous flowers are blooming it is injurious to man. There are likewise wasps which, according to the climate of their home, live now on honey, now on insects; a proof of the adaptability of instinct.

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The *Bees* have evolved along similar lines. They feed their brood not on animal food, but on vegetable substances; and as we have seen in Chapter XII, they brush off the pollen of flowers with special brushes affixed to their legs or abdomens, which retain the yellow dust. The higher forms, moreover, have on their legs spoon-shaped depressions or "bread-baskets" in which they collect pollen, so that they look, as they fly away, as though they were wearing yellow stockings. With their finely developed suctorial organ the Bees also suck the nectar of flowers; the saccharine fluid is mixed with saliva, and regurgitated as honey.

The race of the Bees too begins with solitary forms. We find such bees everywhere in sandy soil: for example, in the Sertão, where they dig deep galleries, at the end of which they build their cells. These are often lined with fragments of leaves; when all is ready the cell is filled with "bee-bread," a mixture of honey and pollen, and on this an egg is laid. The bee now closes the cell, and prepares a new one for the next egg.

She is not interested in the development of her larvae; so that it often happens that during her absence the "Cuckoo-bee" lays her egg beside that of the rightful owner of the cell. The grub of this bee develops the more rapidly of the two, and eats up the bee-bread before the lawful inhabitant creeps out of the egg, only to find that it is doomed to starve.

Among the Solitary Bees are the handsome Carpenter Bees, as large as Bumble-bees, whose black bodies have a blue-green metallic lustre. At Olinda I saw these insects gnawing their holes in a rail-post. Such a hole is gradually enlarged into a gallery, which is divided into cells by lateral partitions, each cell receiving its ration of bee-bread and an egg. The larvae eat their fill, pupate, and gnaw their way to freedom through a series of doors.

The Brazilian Emerald Bee glitters with metallic green, blue and gold. The length of its proboscis exceeds that of its body. These bees have on the thighs of their hindlegs baskets in which they collect not only pollen, but resin for building purposes. They build in the trunks of trees eaten by termites, in keyholes, and in the nests of Mud- or Pollen-wasps, but they also fasten clay balls, as large as walnuts, to the branches of trees, inside which are cells containing eggs and honey. In some of these bees the beginnings of communal life have been observed.

In the Bumble-bees this communal life is already fully developed. Like the Wasps, the Brazilian Bumble-bees are enabled by the climate to maintain their community for long periods, while the community of the European Bumble-bees has less than a year's life, being renewed each spring by a fertilized female. Consequently the nest of the "Mamangabas," as the Brazilians call these bees, is often of considerable dimensions. It is frequently as large as a wash-basin, and is built in the ground, preferably among the roots of a dense thicket. On the floor of the nest a number of separate little pots peep out between the roots and the rotting leaves; they are the waxen cells into which the bee-bread is stored and the eggs laid. The growing larvae are fed by the queen, and later by the worker females, until they pupate in cocoons of their own spinning, which split the waxen shells. Accordingly, we find in the nest many brood-cells in which pupation has taken place, and which have been repaired, or only half filled with honey with a view to a possible scarcity of food. The Brazilian Bumble-bees, which are distinguished by white and yellow stripes on their black-haired bodies, can sting most effectively, and are said to be able to penetrate the thickest cloak. A collector employed by the São Paulo museum was once attacked by the angry insects, and when some infuriated wasps took part in the attack he was so severely maltreated that he fell unconscious, and it was two or three hours before he was found. There is one kind of Bumble-bee which is not content merely to use its sting, but emits a most horrible stench if molested.

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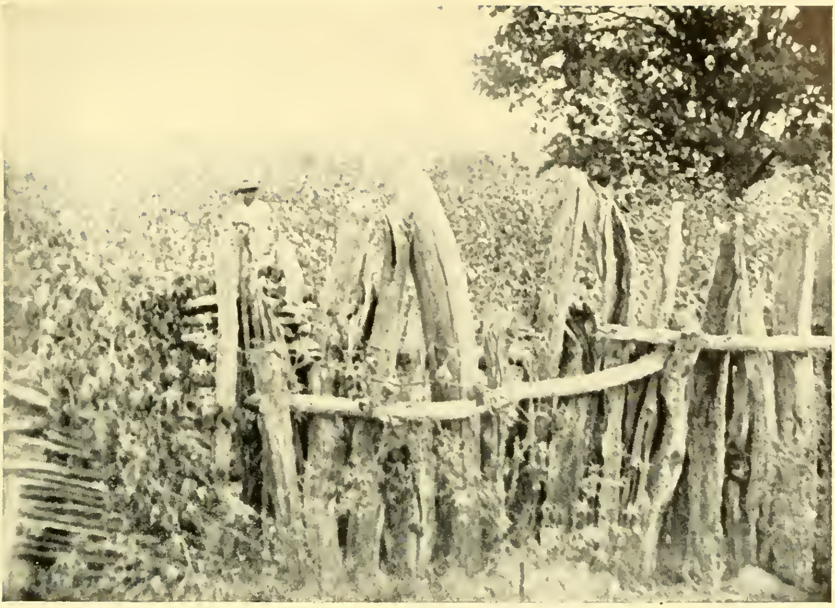
The true Honey-bees of Brazil belong to another group than ours. It is true that in the forties of the last century our European hive-bee, the "Abelha do reino," was exported to Brazil, and it has done very well in the tropics. In the monastery garden at Olinda stood whole rows of beehives; they were densely populated, and as there are always flowers in bloom in Brazil, the bees were constantly carrying honey into the hives. I enjoyed this clear honey every morning: it was uncommonly aromatic, and was all the more welcome inasmuch in those latitudes butter comes to the table in a liquid condition unless a refrigerator is available. To the European the South American honey may seem too aromatic, and, until he is used to it, to taste rather too strongly of a chemist's shop.

The wild bees native to Brazil are found everywhere, and may be regarded as the characteristic insects of the country. They have been studied by many explorers, among whom the German scientists H. von Ihering and A. Ducke are worthy of especial mention. To-day we know of sixty-three species, belonging to the family of the Meliponae; for the entomologists are now inclined to include in this the bees once classified as members of a second family, the Trigonae. The Brazilian bees do not, like ours, employ a sting for attack and defence. But this does not mean that they will allow themselves to be robbed of their honey. There are indeed species,



COTTON-FIELD, SOLIDADE, PARAHYBA

COFFEE PLANTATIONS IN THE HILLS NEAR JAHÚ

EUCALYPTUS FOREST, CAYEIRAS

especially among the smaller forms, which are timid, and will not attack an enemy. Most of them, however, fall without hesitation on anyone who attempts to open their nest, forcing their way angrily into his eyes, nose and ears, crawling under his clothing, and in particular rooting and burrowing into his hair, buzzing and singing the while, for which reason the Brazilians call them "Hair-twisters," *torce cabellos.* Their attentions are so bewildering that the would-be robber generally beats a retreat. But there are species which bite as they attack, smearing the body all over with a resinous substance, and biting off the hair. The "Bora" is such a bee.

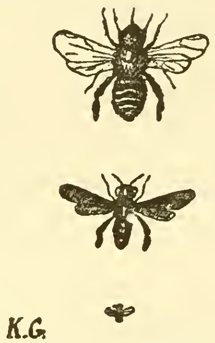


FIG. 25.—Stingless Brazilian Bees. Above, the Urussú. In the middle, the Irapuan. Beneath, an "Eye-licker." (*All shown in their natural size*)

Even away from their nests the Brazilian bees can be troublesome. Some species settle on human beings in order to suck the perspiration which flows so readily in the tropics; others, known as "Eye-lickers," prefer to fly into one's eyes, and are consequently extremely troublesome. These last are tiny bees, barely a twelfth of an inch in length; they are the smallest bees in the world (Fig. 25).

Others have an unpleasant odour of resin, or even of carrion, while there are some which smell like roses, and the Limão bee exhales a strong scent of lemons.

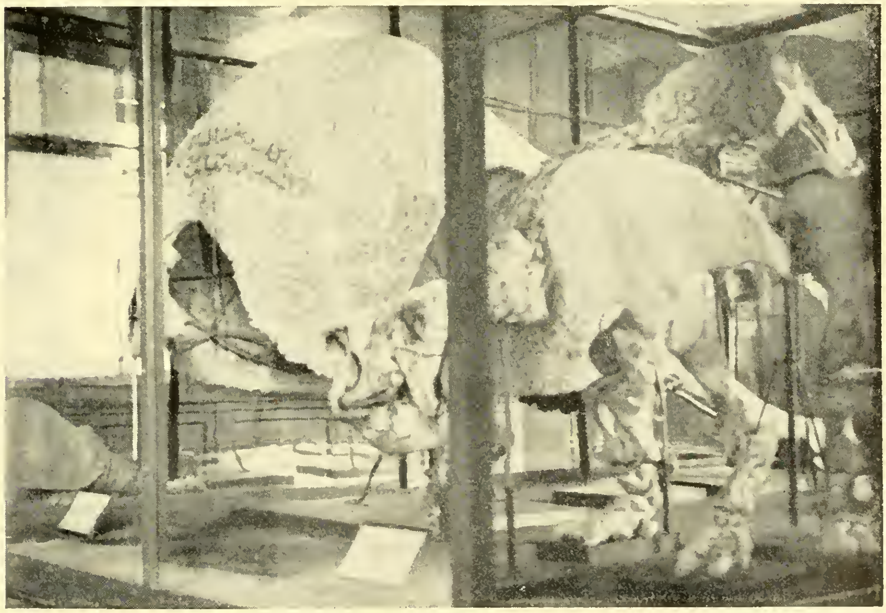
The Brazilian bees are on the whole smaller than the European species; the forms most frequently found are about the size of a house-fly. The body is commonly black; many are black all over, while others have yellow bands on their abdomens, interrupted down the median line. The various species bear names which the first settlers took over from the Indians, and which allude for the most part to their honey and their mode of life. In the Indian language *Ira* means "honey"; and this word is combined with all manner of nouns, adjectives and adverbs to make names for girls; and even to-day many a pretty Brazilian girl is adorned by such a name as Iracema (Honey-lips) or Iracy.

The commonest bee in South America is the aggressive and pugnacious Irapuan (Fig. 25). "Apuan" means "round," and refers to the nest, which hangs on the bough of some forest tree like a great dark ball. The Urussú bees (Fig. 25), which were common in the garden at Olinda, build in hollow trees, and the Cupiras in termitaries (the Termites are known as Cupim). The bees which build in the ground are known as Buira, which means "earth-honey" —from Ubu = earth. Irussu means "much honey" (assu = great). Other names of bees are Mandassaia, Mandaguary, and above all Jaty; and to these we may add Portuguese names, such as Sete portas (seven doors), Mineiro (miner or tunneller), Limão (lemon), and others.

These names show what an important part has been played by the bees of Brazil, especially in earlier times, when the country was still in its natural state. Like the Indians, travellers in Brazil have found an important article of diet in honey; for there are many species which produce from 3 to 25 pints of honey in a single nest, which, according to the species, may include a few hundred inhabitants only, or from 20,000 to 70,000. The honey of the stingless bees is more savoury and aromatic than European honey, and some kinds are held to be altogether superior; it is, of course, thin and liquid, and sets only after it has been boiled; but in Brazil it is quite usual to boil honey. As in the nests of the Honey-wasps, so in those of the bees, one sometimes finds evil-tasting "dog-honey" (mel de cachorro), to which the bees add perspiration and dung, or even poisonous substances. There is no record of any exclusively poisonous honey, but according to the number of poisonous flowers blooming at any time a honey may be more or less poisonous. As a rule violent vomiting results from eating such honey, but a condition of intoxication has been also observed, especially after eating poisonous wasp-honey. The victims are said to run about like mad creatures, tear their clothes, and butt with their heads like goats, until finally they sink to the floor in convulsions.

The nest of the Stingless Bees, though it may be situated in a hollow tree, in a termites' nest, underground, or in the open, on the branch of a tree, is always built on the same fundamental plan. An entrance-hole, sometimes protracted outwards into a long tube, leads to a short gallery, which takes the bee directly to the centre of the nest. Here, in a spherical envelope of several layers of wax, lie the brood-combs, either slanting or horizontal, with the cells opening upwards. These combs consist of hexagonal cells, in which food is stored, the egg being laid on the top of the food; after which the bees seal the cells. The larva, therefore, has to eat in dark and solitary confinement, while the European bees leave the brood-cells open and feed the larvae. The amount of food in the cells of the Brazilian bees is of course calculated, as in the case of the Solitary

LA PLATA MUSEUM, ARGENTINA



PREHISTORIC GIANT ARMADILLO IN THE LA PLATA MUSEUM

Bees, to last until pupation. When the young bees emerge from the pupae, the cells are razed.

The bees' nest, however, does not consist only of the spherical living-room. Above and below this the bees build a great heap of waxen honey-jars, which in the case of some species may be as big as a hen's egg, and are filled with honey or pollen. The pots in the interior of the ball cannot be got at until the outer pots are emptied, when the bees can bite through them. Above and below this mass of honey-pots the nest is closed. If the bees build in a hollow tree they build a cross-partition, the "batumen," which is sometimes as thick as one's finger, and, according to the species, may consist of wax, clay, or resin.

Like the European bee, the Brazilian bee exists in three forms. There are males or drones, defenceless creatures, which, like our drones, have no sting, neither do they bite; and they do not take part in the building of the nest. Their only task is to fertilize the sexually mature female, the "queen." When the mating-time is over they are ejected, as useless mouths. There is a kind of "battle of the drones," during which it has been observed that the workers seize the drones and fly out of the nest with them, or drag them out, and leave them lying outside, having first, by way of farewell, given them a vigorous bite at the back of the head. The drones, in the meantime, do not defend themselves, but only seek safety in flight.

The high-water mark of the drone's life is the nuptial flight of the queen. In Europe, when all Nature is revivified by the Spring, and when all the labours of the bee community have been duly accomplished, the queen leaves her old home with a swarm of workers, in order to found a new community. In the meantime, however, creeping out of her cell, the young queen emerges, circles round the hive, and buzzes off, followed by the "droning" swarm of drones. But only one drone is the favoured spouse, and even he must pay by his death for the intoxication of love; dying, he falls to the ground, while the fertilized queen returns to the hive, and in the community orphaned by the departure of the old queen she takes over the duty of egg-laying.

In Brazil it is not the old queen who departs with the swarm of workers, but the young and still virgin queen, who must take her nuptial flight from her new home, or be fertilized in the hive itself. The old queen, a female who has already laid eggs, is incapable of flight, for her body is unshapely with the masses of eggs contained in it, being four times as large as before, and her weight is that of ten worker-bees; her wings are too small for such a body. Moreover, the Brazilian queen is not fed, as is the queen of the European hive; she has to fetch her own food. When the queen begins to attend to her business in life, she wanders indefatigably over the combs, and lays her eggs in the cells prepared for them. It is in her power to determine the sex of the brood, for the semen of the drone is received in a small pouch near the oviduct, and when an egg, on leaving the ovary and gliding through the oviduct, passes the mouth of this pouch, the queen may open the latter, so that a spermatozoon slips out and fertilizes the egg; or she may keep it closed, when the egg is laid unfertilized. In the first case the result is a female bee, queen or worker; in the second, a male bee. Thus, the drones have no father, and inherit their male qualities from their grandfather, since the queen, when still in the egg, was fertilized at the time of her conception.

The workers are females, but their sexual organs are stunted, and they have no erotic instincts. In return, their bodies are organized with a view to their work; for only the workers bear the baskets for gathering pollen and the brushes for brushing it off; they alone exude the wax for cell-building from the back of the abdomen (our European bees exude it from the underside of the abdomen), and they alone possess all the miraculous instincts which maintain the bee community. The different development of the two forms of female appears to be the result of a different diet. The future queen is given a special food, known as "royal jelly," and the larva grows up in a specially large "royal" cell. Among the Brazilian bees we find "royal" cells only in the higher species; among the less evolved species, such as the Mandassaias, the Tujubas and the Guarupús, only one kind of cell has been found; the emerging queens develop their sexual organs gradually, and apparently do not become sexually mature until their new colony has swarmed. The drones, which in the case of European bees are given larger cells than those of the workers, have cells of the same size in Brazil, and the Brazilian combs are thus on the whole more evenly constructed than the European, though some species produce more irregular combs.

Indefatigably the bees labour in their community, and it is marvellous to behold how delicately they execute their constructive work. Some of the Brazilian bees even begin by laying down a ground-plan of the comb; a plate of wax is prepared, and on this outspread surface the outlines of the cells are sketched; only then is the work of building begun. The entrance-hole is often prolonged, forming a strong tube of clay, which in the case of some species has a funnel-shaped opening. At night this opening is closed; only a few species, which the Brazilians call Sloth-bees, "Preguiças," neglect this precaution. But there is always a sentry on duty; for above all the community must be on its guard against predatory bees, since there are plenty of species which like to save themselves the trouble of gathering honey, and prefer to steal it. Von Ihering records that for him the plundering of his hives destroyed all his pleasure in bee-keeping. The worst of the predatory bees are the red-bellied Tujubas or Urussús.

Many species of beetles and mites live as parasites in the bees' nest, and among external enemies the Eyra cat and the Irara polecat must be mentioned; the names of these animals point to their fondness for honey (Ira, Eyra). Woodpeckers are said to eat bees on occasion; but the worst damage is done by honey-loving ants. There is one species, the "Honey-ant," which is constantly invading bees' nests and hives, either killing or ejecting the inhabitants, and taking possession of the well-stored mansion.

Other ants are on friendly terms with the bees, and sometimes the bees make their nests in close proximity to communities of strong and pugnacious ants, in order to enjoy their protection. Timid and gentle bees, like the small "Jaty-mosquito" bee, actually tolerate ants in their own nests. These "Bee-ants" inhabit the space between the outer wall and the actual nest; they steal no honey, and are apparently of service to the bee. A similar relation exists between the Cupira bees and the Termites, only in this case the more valiant bees defend their hosts. It seems very strange to find a beehive in the interior of a hanging Termites' nest!

But there are yet other insects which maintain friendly relations with the bees. In the garden at Olinda I saw some "Sugar Cicadas" in all stages of development, from the youngest wingless forms, on the twigs of a bush, sucking the sweet sap. The bees were profiting by their presence; whole troops of them were running over the Cicadas, licking their bodies, which exuded a sweet liquid, and eating their saccharine droppings. Even our European bees utilize the excrement with which the Aphides sprinkle the leaves on which they feed, until these seem to be covered with a glossy varnish, in preparing their honey; and since the plant-lice feed only on the sap of plants, this fact need not spoil our appetite for honey. For the bees of which I have just been speaking, the Cicadas were a sort of milch-cow. These insects, which are wholly defenceless, are rewarded for their gifts by the protection afforded by the presence of the bees; and so we find, among the Brazilian bees, the beginnings of relations which reach their highest development among the Ants.

XVII

THE COMMUNITY OF THE ANTS

Wherever one goes in Brazil, in the South, or the North, or the interior of the country, one very soon becomes conscious—unless one's receptivity to impressions has been destroyed by the hurrying life of the cities—of the activities of the Leafcutting Ants or Sauvas. Particularly on dry, sandy soil, like that of the Sertão, one encounters them at every step.

On my very first day in Brazil I encountered the Sauvas on the paths and in the grass at Olinda. Even more striking was their behaviour in the park of Dois Irmãos, outside Recife, which merges into the forest, and contains one of the city's reservoirs. I was walking along the narrow, sandy dam; on the left lay the waters of the great reservoir, blue in the sunlight, and on my right the trunks of the forest trees gleamed white amidst the dark green, glittering foliage. Silent and rigid, a black Pipra, with blood-red head, was sitting in a bush.

But a procession was passing along the sunlit path; a long chain of ants was passing (Fig. 26). These yellow insects one and all bore scraps of leaves in their mandibles; for the most part these fragments were larger than the ants themselves, so that at a cursory glance they looked like green parasols with six legs, staggering and stumbling along the path.

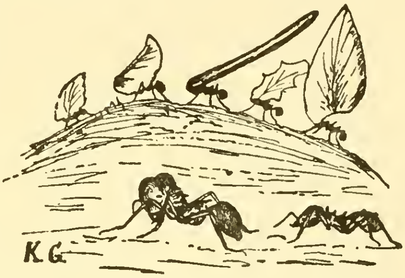


Fig. 26.—Leafcutting Ants or Sauvas, carrying several fragments of leaves, accompanied by their Soldiers (*natural size*)

Many of these insects appeared to be collapsing under a too lofty parasol, but indefatigably they struggled on under their burdens, with a persistence which no obstacles dismayed.

I followed the procession, and soon came to a place where the wanderers turned aside into some short grass, and made for a low, sandy knoll, in which a hole yawned. One by one I watched them disappear into the dark interior of this hole. I pushed the point of my umbrella a little way into the opening; the startled bearers flinched aside, and suddenly some larger ants ran out and rushed at my umbrella, their powerful pincers wide open; in a moment they had clambered up it, and their jaws were clinched upon it, and upon my trousers. These were the defensive forces of the Sauvas' nest, the soldiers. Only with difficulty could these infuriated insects be detached; many of them allowed their bodies to be pulled in two rather than release their hold, and some hours later, long after I had returned home, I found some Sauva soldiers whose jaws were still clinched on my umbrella.

A Sauvas' nest is a large subterranean dwelling, extending many yards in all directions. In the centre, like the crater of a volcano, rises a yellow hill with an entrance-hole, surrounded by smaller hills, like parasitic craters. All the galleries run down to an average depth of a yard or more, where the real nest with its many chambers begins, of which I shall presently have something to say. It appears that the depth of the nest is that of the stratum of the subsoil in which the temperature remains uniform. Under special circumstances the Sauvas build their nests in a different manner; for example, on a hillside near Olinda I found that the chambers lay at a considerably greater depth, while on the shores of the lagoons of brackish water they were nearer the surface, doubtless on account of the danger of inundation.

I have excavated several nests of the Sauva ant: not alone, of course, for that would have been beyond my powers. The first requisite is equanimity, for the Sauvas defend themselves when attacked, and the bite of their soldiers draws blood. In the northern portion of the State of Pernambuco twelve men once worked for six hours with their mattocks, and even then they did not succeed in exposing the whole of the nest. On the land of the agricultural college of the monastery the students came to my assistance; and I admired the way in which these valiant young men, with rolled-up trousers, hewed and shovelled while the blood ran down their legs, for the excavated city was naturally swarming with ants, and the excitement of the soldiers was indescribable. One of the students in particular, Edysio by name, was indefatigable, and always in the best of tempers; a most attractive type of Brazilian.

When, after prolonged effort, one reaches the actual centre of the nest, the mattock lays bare chamber after chamber, and one sees, lying in the dark holes, lumps as big as one's fist, of a very loose texture, and looking rather like sponges; but so fragile that when one takes them out they immediately crumble into dust. The Sauva has hundreds of such chambers; all are connected by cross-galleries of various diameters, so that the whole nest is like a mine.

The spongy lumps are usually a greyish-white in colour, but some are green, and from these one can readily understand what the ants do with the fragments of leaves which they carry into the nest. One sees, too, that numbers of very small ants are always busily occupied with these lumps. These are not, however, young ants; for the ants belong to the Hymenoptera, and these, like the beetles, butterflies, moths and flies, grow only while they are larvae—that is, grubs or caterpillars. In this stage they moult, and each time they burst their old skin they emerge rather larger than before. The period of growth is terminated by the last skin but one, which is discarded by the pupa. During pupation all the organs are, as it were, dissolved and transmuted, and when the pupa splits open in the last moult of all the perfect and sexually mature insect emerges, which is distinguished from all the stages of its youth by the possession of wings, and a wholly different shape, and a different way of life.

Even among the ants the males and females have wings; only the workers, who are really females in whom the sexual organs are stunted, have renounced their wings, as they would hamper them in their subterranean activities. Among the Sauvas we find a whole series of workers of different sizes, whose physical form is determined by the work which they perform in the community. The large Sauvas are the formidable soldiers; the medium-sized workers procure leaves and divide them; the smallest work in the sponges.

When the medium-sized workers have brought the leaves into the nest, they are divided as finely as possible, and gathered into heaps. But this is only a preliminary, for these heaps do not represent the food of the Sauvas; they are merely beds of compost for their vegetables. For these remarkable insects are gardeners, and *cultivate* fungi of a species which no longer exists in the natural state.

Consequently, the ants have always to fetch their fungi from other chambers. These reveal the fact that they have been long established by the grey colour of their spongy contents. They are completely filled with the mycelium of the fungus; and the ants pull out a little bunch of this mycelium, carry it to the heap of green compost, and plant it there. Presently the fungus begins to grow on the new heap, and pierces it through and through with its filaments of mycelium. Gradually little globular nodules form on this mycelium; to my naked eye they were barely visible as tiny white dots. The discoverer of this curious fungus, Möller, called these nodules "kohlrabis"; another name for them is "ambrosia." The extraordinary thing is that the "kohlrabi" is as truly a product of myrmecine fungiculture as our cabbages and cauliflowers are products of human agriculture. For as soon as the ants are prevented from gaining access to their sponges of mycelium the "kohlrabis" disappear, and the fungus puts forth long aerial filaments, so that the whole mass has a mildewed appearance. Möller has actually shown that the fungus will produce pinkish hat-shaped toadstools, about as tall as one's finger, very like an ordinary mushroom. The ants, however, prevent the outgrowth of filaments by constantly biting them off as they sprout; a task to which the smallest of the Sauvas have to devote themselves night and day. And they have also to see to the extermination of "weeds." For with every scrap of leaf a host of other spores—as one calls the reproductive corpuscles of the fungus—are introduced into the nest; and all these must be carefully removed. When the heap of leaf-mould has lost its nutritive properties it is torn out of the mushroom-bed bit by bit, while the gaps are filled up with fresh masses of triturated leaves. Even the outer aspect of a Sauva nest is enough to show that the ants are never idle; into one hole wanders a procession of workers, each bearing a scrap of green leaf, and from another emerges an equally unbroken chain of workers who throw the débris of exhausted leaf-mould on to rubbish-heaps; a spectacle which always puts one in mind of a mine or a smelting works, where débris is constantly being cast away.

The mushroom-nurseries are the actual dwelling-rooms of the Sauvas, and the "kohlrabis" are their only nourishment. When I have been investigating a Sauvas' nest I have always emptied out the whitish sponge-like masses and looked through them, for in them I have found all the forms of workers, the white, maggot-like, shiny larvae, and the equally white pupae, in which one can already recognize the whole formation of the ant. In the mushroom-nurseries the workers pluck the "kohlrabis," eat them themselves, and feed the larvae—or other ants which have so much to do that they have no time to feed themselves. This the ants do by regurgitating the food, masticated and mixed with saliva, into the mouths of other ants. In addition to their own stomach, these creatures actually possess a "social crop"! This is the first to be filled when they eat, although they derive no profit from it, for it is used only for feeding others. Only when they have accomplished this, their first of duties, do they open a valve between the two stomachs, when the social crop allows a little food to fall into the personal stomach; and only then can it be digested by the ant itself. With their social stomachs the ants put the most enthusiastic Socialists to shame!

But the mushroom-nurseries conceal things even more remarkable than ants in all stages of development. I found in them the most extraordinary guests; for example, a Rhinoceros Beetle of respectable dimensions, which is always found in the nests of the Sauva, and there passes through all the stages of its development. The maggot-like larva is as safe from attack by the ants as the grub of the Rose-beetle in the nests of our Wood-ants; the exhalations of this creature have a perfectly horrible odour. In the warm leaf-mould which collects under the mushroom-beds the larvae grow in safety, and feed to repletion. Certain Cockroaches too have a predilection for the nests of the Sauva; I, however, found none, but I did discover a Mole-cricket, which may, of course, have got there by accident. The most remarkable creature I found was a reddish-brown Carabid (Fig. 27), with its larvae, which, when I sent it to the well-known expert on the parasites of ants' nests, the Rev. Professor Wasmann, greatly interested the worthy Father. Heretofore no Carabid had been known to inhabit an ants' nest—at all events, no Carabid of such dimensions ($\frac{5}{8}$ inch in length). And this beetle, which Wasmann has named Coeloxenus Guentheri, after myself, was of a quite peculiar species! It had long bristles on its wing-covers, which, when I held the insect against a dark background, could plainly be seen as a yellow bloom. By these hairs the beetle betrays itself as a true myrmecaean guest and parasite, for they exude a sweet, intoxicating sap, which is greedily licked off by the ants, and explains why the pugnacious insects tolerate this stranger in their midst.

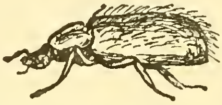


Fig. 27.—The Sauvas' guest, Coeloxenus Guentheri, showing the hairs which exude an intoxicating sap

Carabidae had never before been observed as genuine guests of the ants, but beetles of another family have long been known in this capacity. These are little beetles of the Staphylinidae family or Rove-beetles, whose wing-covers hide barely half the body. These Staphylinidae which are found in ants' nests have also yellow hairs, but they bear them on the side of the body. These beetles are so completely assimilated to the ants that many of them can no longer feed themselves. Indeed, these extraordinary insects have even learned the ants' "language," in which they express themselves by different movements of their antennae. When a worker ant is about to hasten past one of these beetles, the latter will approach her and beseechingly stroke her head with its gently quivering antennae, when the ant immediately places her mouth to the beetle's mouth, and regurgitates into its throat a little food from her "social crop." When the ant has satisfied her guest she considers herself well rewarded for her trouble: she draws a bunch of the beetle's yellow hairs through her mouth, delighting in the sweet exudation.

This juice is the alcohol of the ant community, and as a result of drinking it the ants become more and more addicted to it, neglect their duties to their own brood, and feed only the beetles and their insatiable larvae; and the latter repay their hosts but ill, for there are species among them which devour the eggs and larvae of the ants.

The reader will now ask how it is possible to ascertain that the exudations of the beetles intoxicate the ants. Wasmann has answered this question by some very fascinating experiments. He kept the ants and beetles in artificial nests, under glass, and he always observed that the ants, if their nest (which was usually covered) was suddenly exposed to the light, immediately raised their bodies in the posture of defence, and opened their mandibles. But such of the ants as were sucking the hairs of the beetles could not be diverted from their pleasant occupation. In the case of the large Carabid which I found in a Sauvas' nest, it seemed to me that I could taste, with the tip of my tongue, the sweetness of the secretion exuded from the hairs. In the interest of science I would willingly have undertaken to test in my own person the intoxicating effect of the juice, but I should have needed more beetles than were ever at my disposal!

Still other guests have been found among the Leafcutting Ants, of which to-day perhaps a hundred species are known. There are small cockroaches, which climb on to the backs of the Sauvas and lick them, the ants quietly permitting them to do so. The ants are less contented with certain other beetles, of which we do not yet know whether, in unguarded moments, they do not fall upon the ants or their brood. According to Wasmann such treachery is very probable, since the soldiers often attack them, angrily but ineffectually, since their mandibles glide off the flattened scutum, and cannot grasp the head, which is always held down out of reach. Such "defensive" forms of Coleoptera are not unknown among other species of ant. As a rule, indeed, they escape the attention of the ants, for the beetles living in the dark fungus-chambers resemble their hosts in outward shape and distribution of hair, while other forms, which lurk by the entrances, where the light falls on them, have even assumed the coloration of the Sauvas; in short, they have resorted to mimicry. These last beetles have been seen to hurry to and fro in a warlike manner, with their tails in the air, emitting, at the slightest touch, a strong-smelling fluid; but they hid themselves from the soldiers and workers, and were apparently watching only for the defenceless winged sexual forms.

The different species of Leafcutting Ant display very great differences in the arrangement of their fungus-gardens. In many forms these are as large as a man's head; in others the gardens hang down from the roof of the chambers. Many species even manure the fungus with caterpillar-dung instead of with leaf-mould. Others, again, dig trenches in the soil, and cover them with leaves and dry twigs.

But how, we may ask, does the fungus find its way into a newly-founded ants' nest? Well, the nest is founded by a fertilized female, in silent solitude. These ants are not accompanied by blustering swarms, like those that escort the queen bee; they seem to have learned their lessons from the silence and darkness in which they live. The nuptial flight alone affords a striking and conspicuous spectacle.

Among the ants, as among the bees, the workers are females, whose sexual organs are stunted by a special diet, while their weapons, those tools which they carry with them in the form of their mandibles, have developed all the more vigorously, together with their remarkable instincts, so that in these respects they are greatly superior to the males. On the other hand, the sexually mature females, or queens, have to do very much more than is required of the queen bee.

When the breeding-season approaches thousands of male and female ants rise into the air; for at this critical period of their lives both the sexual forms are endowed with wings, an inheritance from their wasp-like forbears (Plate 29, II, 13). The swarm rises high into the air, and the union of the sexes is consummated in the midst of a swirling dance, while the sun glitters on their transparent wings.

In the case of the Sauvas, however, fertilization appears to take place in the old nest—that is, underground. But the queen may not seek the open air immediately after her nuptials; she has first of all an important duty to fulfil. Quietly she enters one of the fungus-nurseries, and takes into a specially formed pocket in her gullet a tiny tuft of fungus. Now she is ready for her journey; she walks out of the nest and unfolds her wings.

In Pernambuco, and a few months earlier in São Paulo, I encountered the Sauvas at their breeding-season; and on every side, on the paths and in the meadows, I saw females of the size of a bumble-bee creeping over the ground. On the rail-posts and bushes sat Bemtevis, Scissors-grinders and other birds, filling their crops with these "Içás"; lizards pursued them, and people collected them, and gave basketfuls of them to their hens; so that the foundation of a new colony is for the Sauva female a desperately dangerous business. But for the infinite creative powers of Nature, which make up for the wastage by thousands of fresh wanderers, there would soon be no ants left.

Even on her way to her new home the queen loses her wings, or she breaks them off herself, as troublesome appendages, for her next task is to bury herself, and her long wings would be in the way. At last she finds a suitable place, and disappears into the earth. And it is when she is underground that her real work begins. Cut off from the entire world, the queen must rely on herself alone. But here, at least, she is no longer threatened by the enemies that beset her on the surface. She immures herself completely, excavating a little hole with a domed roof, which has no exit to the outer world.

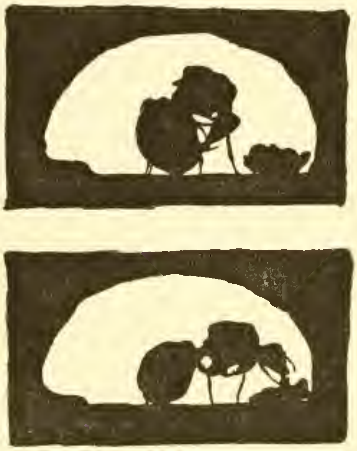


FIG. 28.—Sauva queen in her closed burrow. Above, she is holding a tuft of fungus to her abdomen, in order to manure it; below, she is returning it to its place. (*After the instantaneous photographs of Jakob Huber, natural size*)

The first thing the queen does in her new home is to disgorge the tuft of fungus which she has brought with her, and she at once begins to manure it with her own excrement (Fig. 28). This she does in the most thorough and ingenious manner. She pulls out a scrap of fungus from the growing mass (as Jakob Huber observed in Pará), presses it against her anus, from which at the same moment a drop of fluid exudes, replaces the manured fragment, and presses it down with her feet. But how can the queen produce these excretions, since in her solitary cell she has nothing to eat? Well, she eats some of her own eggs; indeed, she eats no less than 90 per cent. of all she lays.

But those eggs which are spared develop, and presently the first larvae appear. These too are given their own brothers and sisters in the egg as their first nourishment, and their mother's method of administering this diet is as follows: she tickles the larva with her antennae until its mandibles begin to move, whereupon she thrusts an egg between them, often hastening the feeding process by giving the larva a few kicks. The egg is torn open by the sharp mandibles of the larva, and its contents enter the creature's mouth. Huber ascertained that it takes a fairly large larva three to five minutes to suck an egg.

As soon as the larvae have pupated, and the first young workers have emerged from the pupae, the latter help the queen in her work; in other words, they let their droppings fall on the fungus-bed. "It is amusing to see," says Huber, "how the insects carefully feel the spot in question after depositing their dung, and how at times the mother-ant comes and inspects the work accomplished with an air of satisfaction, feeling the place and hastily licking the fungus round about it."

The queen has now accomplished her most important task; she need work no more at building the nest, and she is relieved even of the task of feeding the larvae. For eight or ten days she is constantly at work; then, with her duties, even her supremacy is taken from her. Now the workers excavate a gallery in the wall of the underground colony, and for the first time the air of the outer world enters the dismal chamber. The queen is allowed to eat no more eggs; they are taken from her as they leave her body, and tended by the workers. At the same time the workers begin to make their journeys to the surface; the industrious creatures climb up various plants, cut a circular fragment out of the nearest leaf, until it hangs, so to speak, by a thread, seize it in their mandibles, tear it off, and carry it down to the ground and into the nest. Here the first beds of compost are made, fungus is planted on them, and on the "kohlrabis" which presently sprout from it the larvae are fed, and the queen also. It is hunger that persuades her to this alteration of her diet. From this time onwards she is only an egg-laying machine, and is able to devote all her energies to the business of laying. Thus from day to day the community becomes more populous.

Is it not marvellous that the queen should provide herself with food before migrating from the nest, and should yet refrain from eating this food, but, in order to guard it, should not hesitate to slay her children, that she may preserve the precious substance for the future State? Truly the Leafcutting Ants are an eloquent example of the silent operation of an inner Power in the creations of Nature. And I hope I shall be forgiven if I confess that during my attempts to fight this insect I was always troubled by my admiration for them, although the Secretary of State assured me that if I could discover a means of exterminating the Sauvas I should soon be a millionaire. Hitherto no such means has been discovered. Gassing the nest, or pouring carbon disulphide into it, never kills more than a portion of the widespread community; moreover, the clever insects immediately block their galleries, or even build a second nest, to which they retire with their brood and their fungus-beds, having first cut these latter into little pieces. During such removals observers have noted with astonishment that on reaching the top of a little elevation the insects have allowed their burdens to roll down the slope, to be caught by other workers, thereby accelerating the speed of the removal.

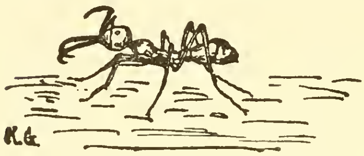


Fig. 29.—Soldier of the Driver Ant, Eciton Burchelli (*slightly enlarged*)

Terrible damage is done by the Sauvas. Many a planter has had reason to despair who one day has looked with satisfaction on a freshly-planted nursery of trees, and on the following morning has found only bare stems. One can hardly hope to console him by the statement that the destroyers of his plantation are among the most wonderful creatures on earth!

. . . . .

Even the smallest of creatures becomes powerful when it combines with its fellows, and when all are inspired by a common will. One can find no better evidence of this truth than a second extraordinary Brazilian ant. In the depths of the forest, in the State of Pernambuco, I first made acquaintance with the Driver or Migratory Ant, which the Indians call Taóca, and the entomologists Eciton. Like a running brook, a yellow flood of insects tumbled over the ground, now surging over the stones, now disappearing in the shadow of the Bauhinia leaves. Even Edysio, the valiant student of whom I have already spoken, fled from the neighbourhood of these ants, whose bite burns like fire. And indeed, if one examines the soldiers of the Taócas, one is thoroughly startled by the unexpected sight of two hooks, as sharp as needles, and despite their slenderness, as solid as steel (Fig. 29). These tweezers, these curved tongs, are longer than the insect's head. The workers have smaller pincers, and as in the case of the Sauvas, there are workers of different sizes. There are many species of Migratory Ant; among them are some which have small eye-spots only, while others are completely blind, or rather, eyeless.

These last, however, despite their lack of the visual sense, have no difficulty in finding their way when they travel in procession. With incredible celerity they dig covered trenches in which they can hurry along in the dark. Bates and Belt are our chief authorities on the life-history of the Migratory Ants, while Vosseler has written of the African Siafu.

All the Driver Ants are famed for their predatory raids, in which they cover considerable stretches of country. The whole animal world is thrilled with terror when the reddish-yellow armies are on the march. In one species the column is four to six ants wide, while another rushes forward in dense masses. Behind them is a serpentine army many thousands strong; Vosseler, indeed, estimated the strength of a tribe of the African Driver Ants at over a million!

A wild flight begins when the Taócas appear. Grasshoppers and locusts leap aside; beetles rush forward, but the terrible ants are quicker; in a trice the victim is struggling in the steely forceps of the soldiers, and the next moment it is cut into pieces. The fragments of booty are quickly handed over to the workers, who carry a larger or smaller joint according to their size. Here an insect clambers desperately up a grass-stalk, but the enemy is after it, and soon it too is seized, killed and dismembered, and its several parts are balanced on the mandibles of the workers. Only the clever Spiders know of a way of escape; they climb a tree, run to the end of a bough, let themselves down by a thread, and hurry away as fast as their long legs will carry them, while foolish insects cower upon the ground and sham dead, but cannot thereby evade their fate.

Now the army comes to a standstill: a fallen tree-trunk bars the way. But already attacking columns are formed, and every hole and crevice in the tree is searched, yielding a very rich booty; for here, in silent seclusion, the fat larvae of beetles are eating their fill. Suddenly the unsuspecting creatures are seized in their asylum, and are cut to pieces before they have fully realized their danger. A wasps' nest which has been built in the tree-trunk is overrun; the paper shell is torn open and the brood seized. In vain the savage humming of the infuriated wasps; as soon as one of them tries to use her sting she is lost; she is seized, and cut to pieces. Even birds' nests and their contents are not safe from the Taócas; and the African Driver Ants are said to kill and eat ducks and hens, and it is even on record that a leopard once fell a victim to them. Nevertheless, the settlers are not hostile to these terrible ants. Once they have been through a house—which the owner, of course, has to leave in all haste, taking with him his domestic animals—there is not an insect left in it; even the most carefully hidden bugs are dragged out of hiding, and the very last flea captured, and the planter contentedly returns to a scavenged house.

Just as a company of raiding lions is followed by vultures, so when the Taócas march through the forest the "Ant-birds" gather from all directions. With its red eyes the "Papa taóca" or "Fire-eye" gazes down from its perch upon the passing multitude, and catches the insects that escape to the right and the left; so that many a locust who deems himself already safe is seized by the bird and borne away through the air (Plate 28, 23). Most of the "Ant-birds" appear to be interested only in the prey of the Taócas, but there are some that eat the ants themselves, when the robber is himself a victim.

Some species of Migratory Ant confine their attacks to other ants. Bates watched the small Legion Taóca fall upon a nest of Timber-ants; in two hours the nest was cleared of all its contents—ants, larvae and eggs; all were dissected and carried off. Sometimes, of course, the ants thus attacked defend themselves, and then there are terrible battles, whose severity is revealed by a battle-field of mutilated corpses. One observer witnessed an attack upon a nest whose defenders boldly rushed upon the foe and pressed the Taócas into the ground with their feet; a method of defence which appears to have been successful.

It is the scent of the leaders that guides the following army. If one throws a little sand on the trail, the ants coming up swarm to the right and the left, but soon gather together again, and, when they have recovered the scent, go forward with renewed confidence. The Taócas have been seen to make living bridges. Difficult crossings are effected as follows: the ants pile themselves up on one another in several layers, and the rest pass across this living wall. Even running water is covered in a similar fashion. The foremost ants are swept away by the hostile element, but those that follow, as soon as they lose their footing, seize one another with their long legs, which are furnished with strong claws, until at last a long chain is formed, which is carried away by the current, but is at last able to anchor itself somewhere. If the two sides of the watercourse can be joined by such means, the whole army crosses this living bridge. In the case of inundations the Driver Ants are said to save themselves by forming themselves into balls, which float on the water, the brood and the sexual forms being safe in the interior of the ball, where not a drop of water reaches them. Such behaviour has been observed also on the part of the Leafcutting ants.

The Migratory Ants have even migratory nests. Taócas have often been found in hollow trees or bushes, gathered together in dense masses, the queen and the brood being in the centre of the mass. Passages are left in the living walls, which are used by the workers who carry provisions into the nest; for raiding parties are sent out from such nests, and return to them laden with booty. Often, too, the nests of alien species are utilized after the rightful inhabitants have been destroyed.

The removal from such nests is effected with the greatest care; for on such occasions no raid is in question, but only a migration. Nothing is killed, for the workers have enough to do to carry the brood, and the soldiers station themselves on either side of the migrating host, protecting it from alien enemies, and to all appearances overseeing and arranging everything. The blind species build covered corridors from the old nest to the new, so that the precious brood may be transferred without exposing it to sun or rain.

The Migratory Ants, like other species, have guests of alien orders, and of these Wasmann has described an incredible number. The guests of these ants are, perhaps, even more remarkable than those of other species, for they are not merely housemates, but accompany their hosts on their marches, hurrying onward in the midst of the hurrying armies. Some, which are really domestic animals, are seen only during a removal from an old nest to a new one; but there are also hunting companions, who take part in the raids of their hosts, and try to snatch the débris of their booty.

There must, of course, be something about all these insects which prevents the ants from attacking them. There are thickset beetles with long legs, Histeridae, who are protected by their physical formation, for the mandibles of the ants glide off their rounded, thickly-armoured bodies, and their legs are out of reach, since the moment they are attacked these beetles draw them under their bodies. Many of these beetles are content to live on the crumbs that fall from the raiders' table; others vary their diet by devouring the dead bodies of their hosts, or even by attacking the living ants. But such beetles are not always protected by their peculiar formation. In the case of the Xenocephalus, a Staphylinid or short-winged beetle which is generally seen doing the goose-step, quite unmolested, in the midst of the marching army, having evolved a sort of protective roof to its body, on which the jaws of the ants can take no hold, Wasmann found that the legs and antennae had sometimes been mutilated. Probably the beetle, while climbing some little eminence, had fallen over on its back, and the ants, now seeing the under side of its body, realized that it was not so unassailable as it had pretended, and snapped at its struggling limbs.

Certain insects whose presence is dangerous are sometimes found migrating in the midst of the ants. There are flies whose wingless females march with the column, while the males hover above them. These flies have no particular resemblance to the ants, nor are their bodies protected; but they exude a fluid secretion much appreciated by the ants, for which reason they are tolerated. This does not prevent them from repaying good with evil. While an ant is contentedly licking such a fly, the latter abuses its confidence by calmly fastening an egg upon its body. From this a larva emerges which bores into the ant's body, and proceeds to devour it in the usual manner of such parasites, leaving the vital organs to the last. Another fly is the Apocephalus; this is a parasite on other species of ants. As a larva, it eats its way into the head of its unfortunate victim, and continues to eat until the head falls off, when it lives in the head as a snail lives in its shell, so that the observer is amazed to see severed heads mysteriously moving about in the midst of the ants. There are also Ichneumons, which resemble the ants, being wingless, and which, though they are tolerated, or even licked and guarded by the ants, lay their deadly eggs in their hosts' bodies.

The most remarkable companions of the Migratory Ants, however, are those guests—for the most part Staphylinidae—which have assumed the outward likeness of their hosts. Wasmann has told us how perfectly this "mimicry" is adapted to the ends in view. He has shown that the guests of the blind Migratory Ants resemble them in form and hairiness—that is, in peculiarities which the ants can recognize by touch—whereas in the company of the "sighted" Drivers they adopt a "visual mimicry," inasmuch as they resemble their hosts chiefly in respect of their colour. Even among the Ichneumons of which I have spoken there is one species, the Mimopeia, which in shape and colour exactly resembles the smallest of the reddish-brown workers of one of the Migratory Ants—which can both see and feel. Another species, which lives with one of the blind Migratory Ants, has actually adopted the form of these ants, the abdomen being attached by a stalk, though its colour is quite different.

But the supreme examples of mimicry are found among the

Staphylinidae. According to the faculties of the ants with which they associate—some being able to see, and others only to feel—they adopt a "tactual" or "visual" mimicry. Wasmann very rightly observes that we must not assume that the ants mistake the beetles for their own kind. We must look at the matter from another angle. The more alien the form or appearance of the creatures encountered by these ferocious insects, the more likely are they to fall upon them. But anything that evokes familiar emotions tends to appease the pugnacious ants: in which they are by no means peculiar!

Now, in the ants the most important sensory organs are the antennae; and in these two senses are united, in a manner for which we human beings can find no counterpart. With their antennae, or rather with the hairs situated on the nerve-terminals of the antennae, the ants are able to smell, though their sense of smell is presumably something quite different from ours, which is connected with our respiratory organs. But the ants also feel with their antennae. When two ants meet, we see them at once feel one another; that is the first thing they do. By touch they express their need of food; by touch they appeal for help. The ants' language is dependent on these subtly evolved organs.

If an ant encounters a beetle, the first thing it does is to feel the latter with its antennae. And if with these antennae it feels an ant-like body, with the thorax connected by a kind of stalk to the rounded abdomen, and if this creature also emits a familiar scent, the ant receives the impression that it is dealing with one of its own species; the beetle feels like one of its own brothers and sisters, and the ant is not excited, but appeased. In the case of "sighted" ants, of course, the colour of the insect must not disturb this reassuring impression. If, moreover, the beetle possesses hairs which exude a sweet, intoxicating juice, the aggressive humour of the ant is entirely subdued, the pleasant emotions are intensified, and when the beetle in turn strokes the head of the ant with its feelers the same instinct is awakened as would be evoked by similar caresses from the antennae of a sister-ant; the deluded insect applies her mandibles to those of this amiable comrade, and regurgitates food into its mouth.

Thus, the Ecitophya, a beetle, is like a spider when seen from above, but its profile is that of an ant, its body sinking in at the waist; its coloration resembles that of the equally large workers of Burchell's Taóca, a sighted Migratory Ant, which this beetle accompanies on its hunting expeditions. Another beetle (Labidominus), which accompanies a blind Migratory Ant, actually clinging to its hosts, in order to be carried along, mimics the ant by the carriage of its abdomen, so that the inquiring antennae follow the same outline as that presented by the ant's own body. But the finest mimic among these ant-resembling beetles is the Mimeciton (Fig. 30); it is, indeed, one of the most remarkable mimics in the insect world. This beetle has an egg-shaped abdomen, which, as is usual in the Ants but not in the Beetles, is connected with the thorax by a narrow bridge. The thorax too is like that of an ant, and even the head and antennae are equally ant-like. No one who saw this insect for the first time would imagine that it was a beetle. The Mimeciton is a thoroughgoing parasite; it has a covering of hairs which exude a sweet juice, and it knows how to beg for food with its antennae. Only its rust-red colour distinguishes it from the shiny black ant, but in the latter the sense of sight has almost completely disappeared.

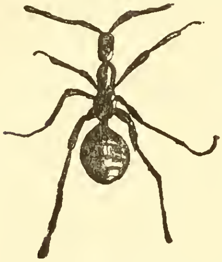


Fig. 30.—Mimeciton, a Beetle which mimics an Ant. (*After Wasmann, enlarged*)

This example shows that the mimicry of the ants' guests is not adopted with a view to the birds that catch the insects which flee before the advancing columns of ants. The guests need protection only from their hosts, for these form a living wall that protects all those creatures that take part in their predatory expeditions, or are merely fed by them.

. . . . .

Another singular chapter of the lives of the Brazilian ants is that which deals with the relations of the ants to the plants of Brazil.

Far above the ground, in the boughs of the Brazilian trees, and especially in the inundation areas of the Amazon basin, anchored in the forks of the branches, which have apparently grown through them, are lumps of earth, overgrown by epiphytic plants (Fig. 31). These veritable hanging gardens are of varying sizes, but some are as large as a man's head. It has been discovered that these lumps of earth, with their epiphytic plants, are ant-gardens. The so-called Aztec ants are the insects which carry the earth up the trees, sow

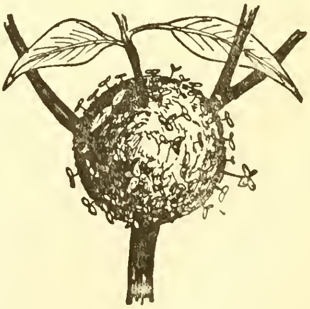


Fig. 31.—Ant-garden on the branch of a tree. (*After Ule, reduced*)

the plants, and as they grow, surround their roots with yet more earth. The advantage which the ants derive from this sort of gardening is that their hanging nest is reinforced and anchored by the roots of the plants.

Another kind of Aztec ant inhabits the interior of the trunk of the Imbauba-tree, and the extraordinary thing about these ants is that the tree does half the ants' work for them (Fig. 32). On the exterior of the slender stem we see, at short intervals, little pits, which the ant has only to bore a little deeper in order to obtain convenient access to the interior. The interior of the tree is hollow, and divided into chambers by lateral partitions, and in these too the ants bore holes. But the Imbauba-tree in question also provides its guests with food. Under the axils of the large, lobated leaves grow cushions of small egg-shaped bodies. These are rich in oil and albumen, and are eagerly devoured by the ants. The colonization of the Imbauba-tree is effected as follows: fertilized females make their way into the chambers, and each founds a colony of her own. Subsequently all these are united by breaking through the dividing-walls; the superfluous queens are killed, and only one remains, who establishes herself in the upper part of the trunk. There is only one species of Imbauba that serves the ants as a dwelling.

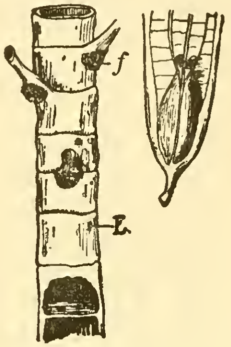


Fig. 32.—Section of an Imbauba-tree, inhabited by ants. E, entrance-hole. Beneath, the trunk is laid open, in order to show the compartments, with communicating apertures; *f*, a cushion of food. To the right, a leaf of a Tococa, with "ant-pouches." (*After Schimper and Schumann, reduced*)

For a long while it was believed that the ants and the tree stood in a relation of symbiosis, inasmuch as the Imbauba offers the ants board and lodging, while they protect its foliage from Leafcutting ants and other enemies. Directly one taps on the trunk the ants rush out, ready for battle. Recent observations, however, have shown that the ants will allow other insects to graze on the foliage undisturbed; even the Sloth is unmolested; and Woodpeckers are actually attracted by their presence. We must assume, therefore, that the evolution of this "Ant-Imbauba" has been conditioned by other factors, and that the Aztec ants have merely acquired the instinct to make practical use of the advantages which it offers.

There are Acacias whose large hollow thorns provide dwellings for certain ants, while little protuberances situated on the tips of the pinnate leaves are eaten by the insects. And the leaves of certain species of Melastomaceae—of whose handsome foliage, brightly variegated, or covered with a symmetrical network of veins, I have already spoken—have developed two bladder-like dilatations on the upper side of the leaves, provided with corresponding openings on the under side (Fig. 32, *right*). These "Ant-pouches" serve as a dwelling for a small, irritable species of ant; perhaps these guests protect the plants against certain enemies; but the problem awaits further examination.

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Some 450 species of ants are known in Brazil; one encounters ants at every step; they are found under almost every stone, and are far more plentiful than in Europe.

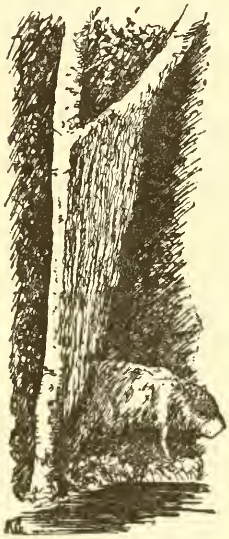


FIG. 33.—Tubular nest of the Beard Aztec. Beneath, a Capyvara or Water-pig

In Brazil, too, the Ants are all the more conspicuous in that certain species, like the Bees and Termites, build plainly-visible nests in trees. The material of such nests is a tough paper, consisting of wood-fibres and triturated wood, consolidated by means of a fluid secreted by the glands of the upper jaw. These again are Aztec ants; but quite a number of other species make nests of papier-maché, sometimes brittle and woody, sometimes thin as paper, and elastic, according to the proportions of the woody material and the adhesive substance. There are even species which utilize the dung of cows and horses in building their nests.

These nests often look like great tumours on the bark, and they are sometimes of considerable size. The nest of the Beard Aztec looks like a giant's beard. It hangs from the boughs in a great mass of long tubes, and presents a most curious spectacle (Fig. 33).

Certain ants make their nests of living leaves, still growing naturally on their twigs. These ants approach the site of their intended nest in company. They take up their positions in an orderly row on the edge of a leaf, and all together grasp the edge of the opposing leaf, drawing it up to the leaf to which they are clinging. If the leaf is too distant for the ants to seize it unaided, they form chains in order to reach it, just as they do in building a living bridge. When the edges are touching, something so astonishing happens that the scientist who first observed the procedure—this was in India, but the ants were of a similar species—could not believe his own eyes. A few of the ants run back into the nest, and presently reappear, each carrying a maggot-like larva between her mandibles. They press the mouths of these larvae to the edge of the one leaf, and then transfer it to the edge of the other; meanwhile the larvae exude some of the silk of which they subsequently spin their cocoons, so that a thread is spun between the two leaves, adhering to the spots to which the mouths of the larvae were pressed.

Thus the "Weaver Ants" actually make use of tools: a rare procedure in the animal kingdom as a whole, but absolutely unheard of in the insect world! And in order that they may perform their work, the larvae have been endowed with particularly well-developed silk-glands: four large sacs, which run the whole length of the body. As the ants constantly ply their living shuttles from leaf to leaf, the threads emerging from the mouths of the larvae, crossing one another in all directions, finally form a solid fabric, which can be cut with a pair of scissors, and binds the edges of the two leaves together. More and more leaves are thus woven together, and at last a green hollow sphere of leaves hangs from the tree, and in this the Weaver Ants live.

The Sarásarás are widely distributed in Brazil; the red-legged species builds semi-spherical nests above the surface of the ground, which, if one cuts them open, reveal a very intricate structure of superimposed galleries of a paper-like substance. The Cupim ants eagerly devour termites, and are therefore useful. One day it was reported that an ant had been discovered which ate the generally detested Sauva. Over and over again these "Cuyabana" ants were actually imported by planters, and they did really drive out the Leafcutting Ants, but only to replace them, and overrun the orchards, on whose foliage plant-lice were to be found. For the favourite food of these, as of other ants, is the sap which the plant-lice suck, and sprinkle over the leaves in the form of their saccharine excretions. These warlike creatures naturally protect the plant-lice from their enemies, and so assist these pests to multiply undisturbed. The Cuyabanas, moreover, make their way into dwelling-houses, and have sometimes made it so uncomfortable to remain in them that the planters have tried to find buyers for their estates.

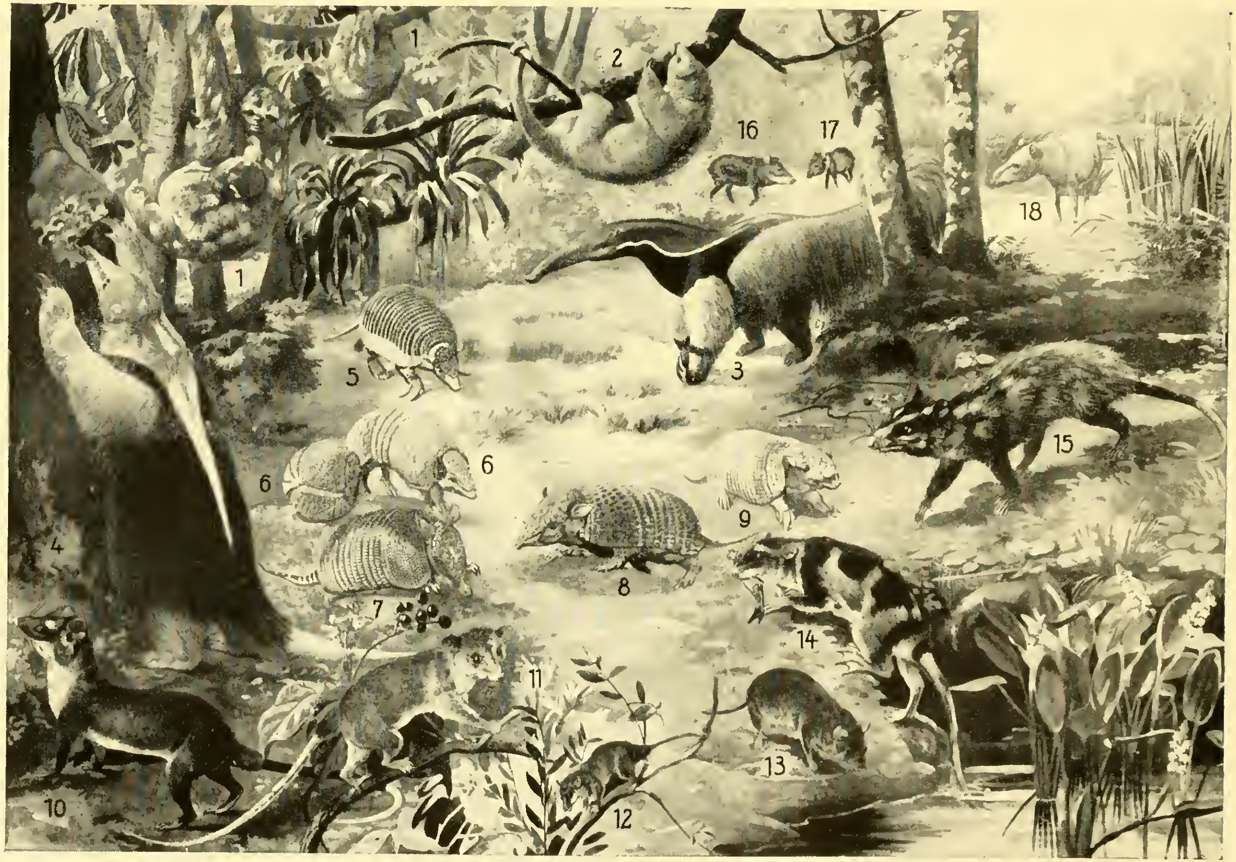
Plate XXVII

THE MORE PRIMITIVE MAMMALS OF BRAZIL

Edentata (*Xenarthra*). (1) Sloth, Preguiça, Ai (Bradypus tridactylus) on Imbauba-tree. In Northern Brazil the Unau (Choloepus didactylus) is found; this has not three but only two toes on its fore-feet. (2) Dwarf Anteater, Tamandua-i (Cyclopes didactylus), hanging from a bough on which Gravatás are growing. (3) Great Ant-Bear, Tamandúa bandeira (Myrmecophaga tridactyla). (4) Tamanduá (Tamandua tetradactyla) opening a Termites' nest. (5) Giant Armadillo, Tatú canastra (Priodontes giganteus). (6) Ball-armadillo, Tatú bola, Apar, Mataco (Tolipeutes tricinctus); on the left, a specimen curled up. (7) Nine-ringed Armadillo, Tatú verdadeiro (Tatus novemcinctus). (8) Six-ringed or White-bristled Armadillo, Tatú do sul (Dasypus sexcinctus). (9) Rat-tailed Armadillo, Tatú cabassú, Tatú de rabo molle (Cabassus unicinctus). *Marsupials.* (10) Opossum, Quica, Chichica (Metachirus Opossum). (11) Woolly Opossum, Mucura chichica (Caluromys philander). (12) Dwarf Opossum, Catita (Marmosa pusilla). (13) Marsupial Shrew-mouse, Catita (Peramys domestica). (14) Water-Opossum, Cuica d'agua (Chironectes minimus). (15) Opossum; known in the North as Mucura, in the North-east as Timbú, in the South as Gambá, in the Argentine as Comadreja (Didelphis aurita; other species, D. marsupialis and D. Paraguayensis). *Ungulata.* (16) White-bearded Peccary, Musk-pig, Porco queixada (Tayassu pecari). (17) Collared Peccary, Porco catete (Pecari tajuca). (18) Tapir, Anta (Tapirus terrestris).

Reduced reproduction of a coloured wall-picture, from the volume of plates *A Fauna Brasileira*, published by the author and the Companhia Melhoramentos (Gebr. Weissflog, São Paulo).

PLATE XXVII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THE MORE PRIMITIVE MAMMALS OF BRAZIL

I myself have searched for ants which might be hostile to the Sauvas. Near a Sauvas' nest on the monastery farm stood a small tree on which lived some large black ants which sucked the sap of plants. If I brought a Sauva to this tree these ants immediately seized and killed it, or at least dragged it away, hurrying down the trunk of the tree. Undoubtedly these ants protected the trees, yet they would not fight the Sauvas in their nest. I often noticed, at night, when the black ants began to spread over the ground, that if they approached a Sauvas' nest they were defeated or put to flight by the soldiers.

There were similar battles when a nest of small black ants was uncovered on excavating a Sauvas' nest. When the terrified Leaf-cutting Ants entered the black ants' nest they were at once attacked by ten or twenty of the dwarfs, and slain. For that matter, the Sauvas' nest contained a number of nests of other species. Embedded in the midst of the fungus-chambers was a thick ball of clay, which was the nest of a species of Termite (Syntermes), and the walls of this nest were traversed by the tiniest galleries, which were themselves the dwelling-place of a thieving ant, Solenopsis Eduardi. The Solenopses had just produced their sexual forms, and the winged ants were pouring forth in all directions. There are thriving ants in the nests of yetot her species; the thieves are always smaller than their hosts, and the galleries leading to their nest are so narrow that no other ants can enter them. Accordingly, when they are pursued by their hosts they have only to withdraw into their corridors. There they are safe. Many of these thieving ants are very dangerous housemates; they slip unawares out of their hiding-places, to seize an egg or a larva of the larger species, and hasten back to safety with their booty.

In the interior of Pernambuco I encountered the giant of the Brazilian ants (Dinoponera grandis, Plate 29, II, 11). The workers of this powerful species are an inch and a quarter in length. These black ants wander singly over the soil of a freshly-planted cotton-field, in which they have excavated their galleries; here they feed their larvae on the fragments of dissected insects, and they do this—unlike other ants—without first swallowing the food themselves, and then disgorging it! The group to which these ants belong betrays, by yet another peculiarity, the fact that it stands at the lowest level of myrmecaean evolution; namely, like the wasps they carry a sting at the tip of the abdomen, while the higher ants have lost their sting, and have retained only the poison-glands. They bite their victims with their pincers, and then squirt their "formic acid" into the wound. This poison is deadly to most insects, and paralyses others. The Dinoponera is feared on account of its sting, which is said to be followed by fever.

Cautiously I captured a few of these black insects, and took them back to Olinda. There I kept them for a long time in large glass jars. They were perfect tigers in insect form. Butterflies, and even bees, which slid fluttering down the glass walls, were caught by the ants, who pursued them, moving their heads from side to side. Then, with their antennae, they pressed the head of the captive to the ground, and against their own abdomen, which was recurved until the deadly poison was injected into the victim. Whatever insect was given them, these savage ants pursued it immediately, and did not rest until they had killed it.

XVIII

THE TERMITES

After a long absence a householder returns home. He unlocks the door, opens it, and sees with pleasure that all is just as he left it. Contentedly he drops into the nearest rocking-chair—an article of furniture seldom absent from a Brazilian sitting-room—and finds himself lying on the floor, with the débris of the chair strewn around him, like fragments of touchwood.

"*Cupim, que diabo!*" cries the prostrate man, angrily. And indeed, the sight of the damage done by the "Cupim," the Termites, is enough to drive one to despair. These insects, which abhor the light, eat their way up from the floor into chairs and tables, but always leave an outer layer, thin as a sheet of paper, so that they may still remain in the dark; and then they transform the furniture into mere phantoms that collapse at a touch. Books too are difficult to preserve in Brazil; in all the libraries one sees the traces of these six-legged miners.

Nevertheless, one cannot but admire the industry and perseverance of these little insects; and one has many opportunities of doing so, for in Brazil one comes upon the nests of termites at every step. In the trees are large black balls, as big as a man's head (Plate 30), which are made of wood-pulp, like the ants' nests of which I have spoken. The material of these nests exhibits vermiform convolutions and all sorts of little prominences: it is brittle, so that one can break off pieces with one's knife. But the Termites also build nests of earth. On travelling by rail from Rio to São Paulo one sees, in many districts, numbers of hillocks, more or less pointed, rising from the ground. These consist partly of clay and partly of earth, or a mixture of the two; sometimes too masses of wood-pulp are added. These hillocks attain considerable dimensions, although the Brazilian termitaries cannot compare with the Australian, among which turret-like nests twenty feet in height have been observed: the largest examples of animal architecture known. Escherich justly remarks that the achievements of these little insects teach us convincingly what a social sense and a communal life devoted to common labour can accomplish.

The Termites are much feebler and more delicate than the Ants; they do not possess the solid armour of the latter, but are softskinned insects. On account of their colour they are often called "White Ants," but this description is misleading; the Termites are quite unrelated to the Ants, but are rather relatives of the Cockroaches. The difference between them is seen most plainly in their mode of development. In the case of the Ants, a grub-like larva emerges from the egg, and grows through several moults until it pupates; then, from the pupa, crawls the mature insect. In the case of the Termites the larva which creeps out of the egg already resembles the adult insect; it has six legs, and only the wings are lacking. These, however, do not make their appearance suddenly, but are susceptible even in the young larvae, and grow larger with every moult. Since the worker termites have no wings, they resemble the larvae; one may therefore regard them as immature forms whose development has been arrested. Unlike the worker bees and ants, the termite workers are of both sexes.

But among the Termites too the workers are the soul of the nest, and its real rulers. They are its architects; it is they who bring in the food; they feed all the other forms of citizens; they guard and tend the eggs, and keep the nest clean. Accordingly, they constitute the greater part of the population of the termitary. And even the maintenance of the numerical strength of this population is left to them. It is within their power to turn worker larvae into sexual forms if the nest has need of more males and females; it is also within their power to transform the larvae of sexual insects into workers before they have completed their development. If there is an excess of any form of termite a radical remedy is applied: the surplus insects are eaten, or simply killed.

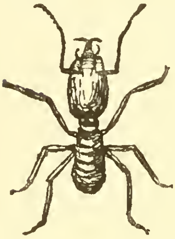
Fig. 34.—Termite Soldier (Termes inquilinus) (*enlarged*)

As far as we know, it is the food that determines the development of this or that form of termite. It has even been ascertained that the intestinal parasites of the termites play a certain part in their development; it has been found that in the adult termites these are numerous, whereas they are lacking in the larvae which are being reared as sexual reserves; so that it seems as though their presence hinders the development of the organs of generation. By feeding the larvae on pure saliva the termites are able to prevent the appearance of parasites in their intestines, and as a result the generative organs are enabled to develop.

The nest is defended by the soldiers (Fig. 34). One makes the acquaintance of these insects immediately if one disturbs a termites' nest, or begins to destroy it. In a moment termites with large heads make their appearance. The dark yellow colouring of the head betrays the fact that it is more solidly protected than the body, and as a matter of fact it contains the muscles which operate the mandibles. During my visit to Ceylon I learned something of the termite soldiers when one day I opened a clay nest. The soldiers rushed out in such numbers, and bit so viciously, that my hand was actually bristling with their little bodies, all standing tail upwards. As a rule the soldier's valour is repaid by death. It will not release its hold once it has closed its mandibles; if one tries to remove it the body comes away in one's fingers. The termites of Ceylon do no more than irritate the skin, but the warlike African termites bite until the blood flows in streams, as the zoologist Escherich experienced in his own person.

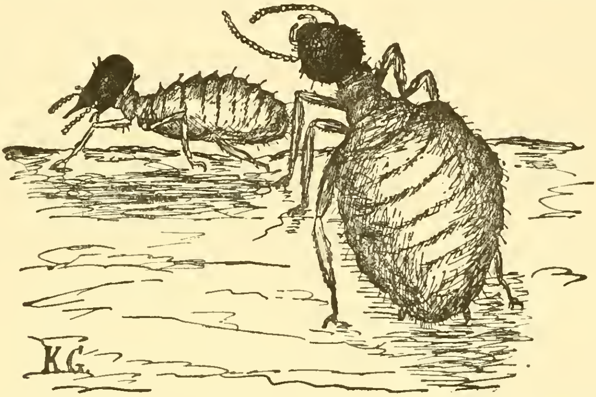

FIG. 35.—Soldier (*left*) and Worker of Eutermes Rippertii (*greatly enlarged*)

Unlike many species of ants, the termites are not aggressive, and their soldiers are equipped for defence rather than for attack. With their great heads they close the entrances to the nest; if any other insect approaches they lay about them blindly with their open mandibles. But there are soldiers in whom aggression and self-protection are identical. In the Brazilian Jumping Termite the soldiers close their long mandibles so quickly that one hears them click, and the insect is thrown back into the gallery by the recoil. In other species the soldiers sound the alarm in case of danger. They quickly rap on the ground with their heads, and those behind them repeat the movement; in some species the resulting sound is said to resemble that emitted by the rattlesnake.

The soldiers of the Eutermes family, to which those termites belong that build spherical nests of black papier-maché in the trees, have quite a different appearance. They have no pincer-like mandibles; but the front of the head is drawn into a point, giving the insect a most singular appearance (Fig. 35). A corrosive mucus appears to be secreted by the spike or "nose," and if one angers a community of such termites the result is a mass attack of the "Natsuti"; one is simply overrun by the insects, which cause an unpleasant irritation all over one's body. The soldiers of these termites often give the workers an encouraging dig with their proboscis, in order to spur them to greater diligence, and in general they act as a kind of police-force.

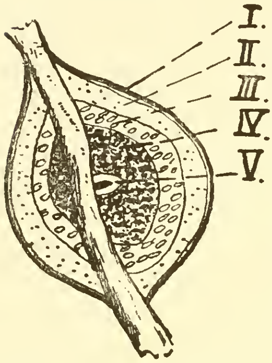

Fig. 36.—Schematic representation of a nest of Eutermes Rippertii (*in section*)

I. Covering layer; II. Stratum of small cells; III. Stratum of larger cells, for fungus-beds, and the larger, winged larvae; IV. Stratum of flattened cells for eggs and brood; V. Queen's cell. (*After Holmgren*)

Let us now examine the interior of a termites' nest. Here is a great lump of the trunk of a tree (Plate 30); we will try to detach it, working from the edge. First we break away a thin covering layer; under this is a second layer, equally brittle, which contains a number of round cells. Adjoining these are the dwelling proper and the brood-chambers of the community. We find small chambers which shelter the larger larvae, and others which serve as store-rooms. The fourth stratum contains flattened cells for the younger larvae and the eggs, and from this, by means of galleries which traverse the whole nest, the central and most vital portion of the nest is reached. This may be recognized by the very solid wall which has to be broken through; it is like a central kernel (Fig. 36, V). In the midst of this kernel is the royal chamber, a large, flattened cell with a domed roof.

From this centre the life of the community radiates; from this centre it is renewed. For in the royal chamber lives the queen, the fruitful female. Anyone who sees her for the first time will be amazed by her extraordinary form (Fig. 37). To begin with, her size is impressive, for compared with the other termites she seems a very giantess. But her shape is even more singular. The fat white body is the monstrously dilated abdomen, grotesquely swollen by the masses of eggs that fill it and are constantly being removed. On this body the head and thorax, with its six legs, look like the little knot at the end of a sausage. With such a figure it is of course impossible that the queen should ever leave her cell; even if she could force her way through the galleries—which are all much narrower than her body—her monstrous abdomen would make all progress impossible when she reached the outer world.

But the queen is not alone in her cell. Her spouse shares her quarters with her. The male selected for breeding purposes has thus a better time of it than among the bees and ants, for he does not pay for the pleasure of the nuptial flight with his life, but is permitted to accompany his queen to the royal chamber. This peculiarity of the Termites is explained by the fact that in the case of these insects a single act of fertilization does not suffice the queen for the period of her life; on the contrary the king has to be constant in his duty. The fertility of the termite female is consequently inconceivable. Escherich has calculated that in the course of her ten years' life the queen lays a hundred million eggs.

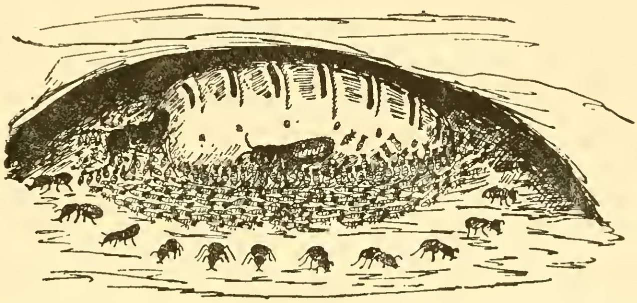

Fig. 37.—Termite Queen, with vast abdomen, surrounded, fed, cleansed and licked by Workers, and guarded by a ring of Soldiers. Beside her is the "king." (*After Escherich*)

And actually, if one watches the queen in her cell, one sees that once in every two seconds an egg emerges from the opening in her abdomen. It is instantly grasped by one of the workers who constantly surround the queen, and even climb upon her body, and is borne out of the press, cleansed, and carried to the adjacent chambers, the nurseries, for further tending. The process is repeated with mechanical regularity. Since the stream of eggs never ceases, the workers have constantly to leave the chamber, and since among them there are those whose duty it is to feed the queen—a few of them are always busy about her mouth—the great number of workers in the queen's chamber is readily explained.

But there is no aristocratic repose in the royal chamber, and the workers have no excessive respect for the queen; for that matter, the latter serves the termites as a sort of sweetshop! From time to time large drops of a clear fluid exude from the queen's abdomen, and these are at once eagerly licked up by the workers. Even the perspiration springing from the obese body during its strenuous labours is licked up, and when the queen grows old, and perspires no longer, the workers do not scruple to bite into her skin and tear away whole shreds of it.

It is part of the workers' duty to cleanse and feed the king also. Straddling he stands beside his spouse, like her, larger than the workers, who run between his legs, while he admonishes them from time to time, by butting them with his head, not to neglect him. Some smaller soldiers run to and fro among the workers, acting as police and overseers, while a ring of larger soldiers surrounds the whole throng, from which the abdomen of the queen rises like a mountain, all their mandibles being directed outwards, in order to defend her against any impertinent intrusion.

A monotonous existence, to spend all her life in a dark cell, and lay an egg every two seconds! Only in her youth, and then only once, does the queen see the light of day. When the time has come for the termite community to multiply, the whole nest is full of thousands of winged males and females, who await in all the chambers and corridors the signal for nuptial flight. First of all workers and soldiers appear outside the nest, and make sure that no danger threatens; then they hurry back, and the signal is heard; and now the winged throng discharges itself like pattering raindrops from a thundercloud. Once in Ceylon I had the good fortune to witness the departure of these white insects, not unlike our Mayflies in appearance. In the uncertain glimmer of a stormy evening sky whole clouds of these insects rose into the mysterious darkness, their glittering wings filling the air with a shimmer of mother-of-pearl. But the sheer beauty of the spectacle was spoiled when I drew nearer. The ground was covered with fat toads and lizards and other creatures: some had climbed half-way up the tree; they were all busily swallowing, and the termites thronging forth on their nuptial flight left their dark corridors not for the cool open air, but for the jaws of a devouring enemy.

If one happens to be sitting by an open window with a lamp on the table when a swarm leaves its nest anywhere in the neighbourhood, the table is immediately covered with the fat white insects.

If there is food on the table one has to send it away, for all the dishes are full of a struggling broth of termites. In view of the innumerable dangers which threaten the sexual forms on their emergence, it is only by a mass migration that a new community can be founded.

If at length a pair of termites have escaped the perils of the nuptial flight, they are still by no means in safety. From the limpid air they fall to the ground. From aerial they have become terrestrial creatures, and the first thing they do is to spread out their four wings, and break them off by twisting their abdomens. Male and female are now wingless, and in this form they begin their honeymoon. The female stalks on ahead; the male follows; creeping over the irregular surface of the soil, they are beset by a thousand dangers, to which many a pair of lovers fall victims.

At last our two termites have found a suitable site. They bore their way, according to their species, into the earth, or the bark of a tree, or what not, in order to prepare the nuptial chamber; for the termites do not wed in the air. And even in the nuptial chamber union does not take place at once; there is first a long "engagement," for only gradually do the insects become sexually mature. When the female is at length fertilized the already swollen abdomen gradually attains even more enormous dimensions. But for a long while yet the two have to keep house alone, cleansing the eggs and feeding the larvae; it is, on an average, a year before the larva has become a worker, so that it is a long time before the offspring reared are so far advanced that they can take over the labours of the community, and, above all, enlarge their native home.

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If we examine the architecture of the individual species of the Brazilian termites, we shall find very great differences. There are artless termites which merely gnaw passages and shallow chambers under the bark of trees, and others that make similar nests in the soil. In the papier-maché nests built in trees we find structures with a nucleus, the royal cell, around which the others are arranged in strata. The "ant-hills" of the South American terrestrial species are built in storeys; in the fourth storey a cell is set aside for the royal pair, but there is no special central nucleus.

I have already spoken of underground nests; when describing the nests of the Sauva I mentioned a spherical clay termitary. In such nests the chambers are arranged like the steps of a spiral staircase. There are spherical nests which lie on the surface of the soil, and there are also mixed nests: in short, we find the greatest variety of architectural forms.

The termites make covered galleries from their nests to the places from which they fetch their building-material or food. They dread the light; indeed, a great proportion of their workers and soldiers are blind. But in order that their activities may not be wholly confined to the hours of the night, the termites build long, branching galleries on the surface of the soil, which run up trees, and enter rooms, ending on the planks of the floor, or against a table, through which they eat their way, still further extending their runs. If we destroy such a corridor the white insects appear immediately and proceed to repair it, and in a little while the passage is again roofed over.

Neat and artistic though the nests and galleries of the termites may appear, their building-material seems to us both strange and repulsive. The Brazilian naturalist Fritz Müller was the first to observe the manner in which one arboreal termitary was repaired when partially destroyed. At first a few soldiers appeared; under their protection the workers came forward; they felt the breach, and turned round, when each excreted a brown vermiform dropping. Dung was here the building-material employed; and as a matter of fact it is the material employed by the majority of the termites. Now and again a termite regurgitates undigested material, but as a rule it has already passed through the intestine of another termite; for these insects think nothing of devouring the dung of their comrades.

If, however, we look more closely into the origin of this building-material it begins to seem less repulsive. If we cut off the abdomen of a worker termite, we find that the intestine is always full of wood-pulp or earth, according to the species. These substances are swallowed only to be transmuted by the bowel into building-material, and we understand that Nature has confided to the bowel of the termite the work of preparation which we perform in a tub or pit when we mix loam and water with the necessary mortar. Fritz Müller's observation, that the spherical arboreal nest of the termites is really nothing more than the latrine of a whole termite nation, need not, therefore, fill us with disgust, for the termite's excretions have very little in common with animal dung.

Further, it must be noted that such nests are not built on the tree, as would seem to be the case at first sight; on the contrary, they grow out of the tree. Creatures of darkness, the termites emerge from the interior of the trunk; it is the wood of this trunk that passes through their bowels and is ejected into the outer air. The earthen nests also are built in a similar fashion; the termites excavate galleries in the subsoil, eating the earth, so to speak, and ejecting it from their bowels at the surface. With such a method of nest-building, the more chambers are excavated, the thinner the dividing partitions become, and as all the material removed is utilized for further building operations, it may pass several times through the bowels of the diligent architects.

As for the actual food of the Termites, they are anything but particular; it is precisely because they eat anything that their mandibles can triturate when they enter a house—wood, paper, leather, textile fabrics—that they are so destructive. Like the Ants, the Termites do not eat only for themselves, but also in order to feed king and queen and larvae, and others of their kind; they either regurgitate the food into the mouth of the hungry insect, or they excrete it, when the recipient sets its mouth to the anus of its benefactor. But there are termites, members of the Termes family, which cultivate fungi after the fashion of the Sauvas. They prepare cavities in their nests, which soon become filled with brittle, spongy masses; in the fresh state these are moist to the touch. These are the compost-beds for the fungi; they consist of vegetable matter, wood and leaves, which have passed through the intestines of the termites. The fungus cultivated by the termites is of another species to that grown by the Sauvas; but in this case two special nodules are produced, which are rich in albumen, and constitute the diet of the whole race.

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Like the Ants, the Termites are friendly only to the members of their own community; inmates of another nest are, as a rule, promptly attacked and torn to pieces, and on occasion the termites too fight pitched battles of a deadly character. Very often, and especially in the case of the species whose soldiers are "Nasuti," the workers are the real fighters, while the soldiers only give orders and spur them on. But skirmishes between "Nasuti" have been observed, in which these curious warriors spat so persistently out of their frontal faucets that the one side was eventually covered in stringy slime and glued to the ground.

Termites recognize the inmates of their own nest by the "nest-odour" which clings to them. Once, when a worker was washed and dried and returned to its nest, a group of astonished soldiers immediately surrounded it, but they took care not to touch the strange-smelling creature. Suddenly one ran back into the nest; apparently it wished to report the presence of the stranger, and ask for instructions. Shortly afterwards a worker appeared, felt the supposed stranger with its antennae, convinced itself that the intruder had not the smell which it was a point of honour for any inmate of that nest to emit, bit its head, and ran off. Possibly it reported the case, and some other worker thought the punishment insufficient; at all events, a second worker appeared, bit the unfortunate insect's head off, turned round, and deposited its dung on the corpse, as a sign that the foreign body, having been suitably disposed of, might now be immured.

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But there are also alien inhabitants of the termitary. As I have already related, I found a termites' nest enclosed in a nest of Sauvas, and in the termites' nest were the galleries of the thieving Solenopses. These thieving ants are everywhere frequent in termitaries, and they are dangerous guests, for ever slipping out of their narrow galleries, in which they are safe, and stealing whatever they please. Very often there are several species of such ants in a single termitary, indeed, six different species of ants have been found in one and the same nest, but a few of these lived entirely to themselves, so that a relation of mutual tolerance had developed.

One species of termite, which builds nests of earth, seems actually to be on friendly terms with a certain species of ant, an attitude which is apparently based on the exchange of mutual benefits, for the ant finds a convenient dwelling provided in the nest built by the termites, and valiantly protects not only the nest, but its hosts, against the intrusion of other ants. For the ants are wellnigh the most terrible of all the termites' enemies, which include anteaters, armadillos, woodpeckers and other birds, lizards, toads, wasps, and predatory beetles. The Driver Ants will clear out a termitary to the last egg, and during their wedding-journey the nuptial pairs of termites are only too often the prey of ants, from which nothing can successfully hide. Indeed, many ants wait at the exits of the termitary at the season when the sexual forms fly from the nest, seizing and tearing to pieces every winged termite the moment it shows its head. The stingless bees, on the other hand, which are given to invading the nests of the arboreal termites, although they deprive their hosts of a great part of their dwelling, may possibly afford them some protection.

But species of quite other classes of insects find their way into the termites' nest. As among the ants, so among the termites we find guests which, in appearance, and presumably even in their odour, imitate their hosts. I myself found a remarkable beetle which I recognized as such only because I happened to remember Wasmann's illustration of the insect. It is a long, lanky creature, with a soft abdomen, and two long membranous hind-wings, which, as in the winged termites, stand out from the body, while the fore-wings are small. Its unusually large eyes must help it to find its way about in the dark nest, and it is quite possible that its termite-like form, which would reassure its hosts on their examining it with their feelers, enables it to steal eggs and larvae.

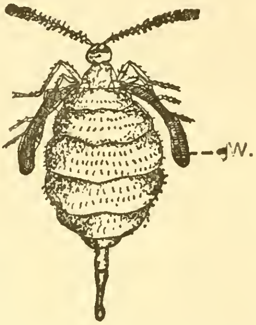

Fig. 38. — A Fly, the guest of the Termites (Termitomastus leptoproctus. W, W, wings transformed into handles. (*Enlarged, after Silvestri*)

The Staphylinidae, of which, as we have seen, "defensive" forms occur in ants' nests, are not unknown in the termitary. They are distinguished by their solid scutum and flat conical form, which makes it impossible for the termites to seize hold of them. The genuine guests of the termites are for the most part distinguished by a monstrous abdomen, the back of which rises high above the level of the thorax, and bulges over the latter in front. One beetle of this kind has been named the "Maid of Honour," on the supposition that the insect was appointed, on account of its "graceful figure," to keep the royal pair company, and that the termites took a purely intellectual joy in its comeliness! Perhaps the discoverer of this beetle was thinking of the Hottentot women, whose abnormally fat buttocks are reckoned a beauty by the men of that race.

It was once more Wasmann who corrected this all too poetical assumption. According to him, the enlargement of the abdomen of these guests of the termitary has no other purpose than to make the insects fat, so that they constantly perspire, when they can be licked by their sweet-toothed hosts. There are flies, too, which are received as guests for the sake of their exudations. And these flies have really touched the highest point of the evolution of insect guests.

The transformation of the bodily form of these flies is so unprecedented that it was a long time before even so great an expert as Wasmann recognized the insects as flies. Their wings are long, narrow, and curved. They serve not only as balancing-poles when the insect is running; they are used by the termites as the handles by which these living bottles are carried when their hosts wish to enjoy a little orgy. The abdomen is enormously distended, for these flies are given plenty to eat; the termites see to this, for the excrement of these insects is a delicacy to their hosts. Consequently they are for ever feeding and cleansing their singular guests: by no means to the profit of the community. The excrement of these flies is a mere luxury, and it so intoxicates the termites that they forget their duties for it.

The reader will involuntarily compare the indulgence of the ants and termites in such intoxicating juices with the consumption of alcohol by human beings, and its enervating effects. And it is indeed a remarkable fact that social life, which multiplies the achievements of man, and gives the greatest possible protection to the individual, should prepare the soil for the phenomena of degeneration. It is as though Nature wished to remind us that even States are not enduring phenomena in the eternal flux and change of terrestrial affairs, but that the more secure they seem on the outside, the more menacingly does the germ of destruction grow at their very heart.

XIX

SNAKES AND BLOODSUCKERS

To the traveller who is bound for the tropics the astonished question is still often put, whether he is not afraid of "the wild beasts."

Those who know the tropics will smile at this question, and the matter-of-fact traveller, if he is asked to relate the dangers he has passed through, will think of illnesses and accidents, and difficulties caused by human beings, but not of the so-called "wild beasts." Neither the elephants, leopards and bears of Ceylon, nor the jaguars and pumas of Brazil prevented me from wandering all day long, and even by night, through forest and jungle and plain, often alone, and almost always unarmed. I never had the slightest fear of being eaten, and as the reader sees, I was not eaten. In the virgin forest of the highlands of Ceylon I often heard the leopard growling from the thicket, and the dogs, if any were with me, squeezed themselves between my legs, for they knew perfectly well that if they swerved a few paces aside they would find themselves in the fangs of the great cat, which has a particular liking for dogs' flesh. Only once was I possibly in danger. I was driving along a road that ran through extensive woods, when an elephant was reported; he had taken up his position a little way along the road, and it was said that more than once he had simply made mincemeat of anyone or anything that came in his way. For this elephant was a so-called "rogue"; that is, an old male who had been turned out of his herd, and was therefore, as an animal to whom society means more than anything else, quite justly infuriated. But on this occasion the elephant did not appear.

But I will not speak of my own unpretending travels; I will rather appeal to an African explorer who has travelled in absolutely unexplored and quite uncivilized regions. I mean the late Professor Georg Schweinfurth, who spent a great proportion of his eighty-nine years in Africa. Looking back over his life, he declared that the only occasion on which he could remember to have been in deadly peril was during the bombardment of Alexandria by the British fleet in 1882, when he was living in the heart of the revolted city. The other great African explorers have expressed themselves in similar terms, and Gerhard Rohlfs, the most successful explorer of the Sahara, stated that he had never so much as caught sight of a lion.

The so-called "wild beasts" have always avoided man, but it is in these days of long-range rifles that they have really taken to hiding themselves, or decamping as fast as they can, since they can no longer count on an approximately equal fight. Dangerous wild animals are now found only in books of juvenile fiction, whose writers have no particular scruples as to what they offer their readers. There you may find such descriptions of lions and tigers as would naturally come from the pen of a reader of sensational fiction. What an excellent thing it would be if our books for boys, instead of constantly rehashing crude and antiquated tales of imaginary perils, were to describe the more fascinating aspects of animal life!

But while the ordinary traveller through forest or plain need have no fear of danger from wild animals, the hunter, I need hardly say, should not neglect ordinary precautions. A hunting expedition will persistently follow up the great cats, or elephants, or rhinoceroses, or what not, tracking them in order to kill them. That many animals attempt to defend themselves when brought to bay is hardly to their discredit! Almost any animal, if it can see no way of escape, will turn on the aggressor. An animal driven into a corner is always dangerous, whether it be a lion or a rat. A case is on record of a rat which, having been chased about a room and finally driven into a corner, suddenly turned and sprang at its persecutor and bit through his jugular vein.

But the snakes, the snakes, you say! Thousands of human beings die of snake-bite in India every year!

Well, one must not assume, without further inquiry, that every report of death from snake-bite is to be accepted as true. The Indian natives are not fond of calling in the police when a murder is committed for jealousy or some other motive; they prefer to give out that the death was due to snake-bite. It is said that this fact explains the high statistics of death from snake-bite. However this may be, in respect of the danger to life from the Indian snakes, I will refer the reader to a writer who knows his India. Mahatma Gandhi says, in his *Guide to Health*: "Even to-day, in respect of snakes our superstition knows no bounds. Experience has taught us that snakes never attack of their own accord, but that they use their fangs only in self-defence when they are in some way molested or irritated. We must not forget that the snakes were created by the same God Who made us also, and all other creatures. Thousands of yoghis and fakirs are to-day living, like St. Francis, in the forests of Hindostan, among lions and tigers and snakes, but we have never yet heard of their becoming the prey of these creatures. I have a profound conviction that a man will not be attacked by other living creatures as long as he himself leaves them undisturbed."

So says the Hindu sage: let us learn of him!

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Many fairy-tales have been told of the dangerous character of the great Pythons.

It is, of course, generally realized that the larger serpents are not venomous, but many of us have read with a shudder how the long body of the Boa constrictor suddenly winds itself round the traveller in the forest, and how its coils draw closer and closer together until finally his bones begin to break.

A reasonable man ought to ask himself with what possible object a snake would break a man's bones? A snake overpowers only such creatures as it can eat, and no snake has yet ever swallowed a man. The stories of gigantic serpents that coil themselves about human beings must be relegated to the region of fables.

In addition to a few rarer species, Brazil possesses two giant snakes. One of these is the Sucury or Anaconda. This is one of the largest snakes in the world; specimens have been measured which were 24 feet in length, and I saw a very large Sucury in the zoological gardens of Rio. The Sucury is a water-snake, and is helpless on the land. The Amazon is its favourite haunt, but it has become rarer even there by reason of constant persecution, for very few men can bring themselves to allow their boat to pass a snake resting on an overhanging bough without firing at the reptile.

The other giant snake, the Giboya, Cobra do veado or Boa constrictor (Plate 31, 1), is a terrestrial reptile. I have often come across this snake, though the specimens which I encountered were not fully grown. The adult boa is as a rule about 13 feet in length. Once we found a boa on the windowsill of the sacristy of the deserted monastery at Monte (Plate 19). I induced him to creep into a large box, and delightedly took him home with me. During the rest of my stay in the monastery the snake lived in my room, and became quite tame, so that I found it hard to part with him.

Such a Giboya is a magnificent reptile. I was never tired of admiring the rich and delicate pattern of his skin—a pattern of spots and chains in various shades of reddish or blackish brown, upon a background of grey, brown and yellow. The tail in particular, brown, yellow, and almost blood-red, glowed with colour, and the

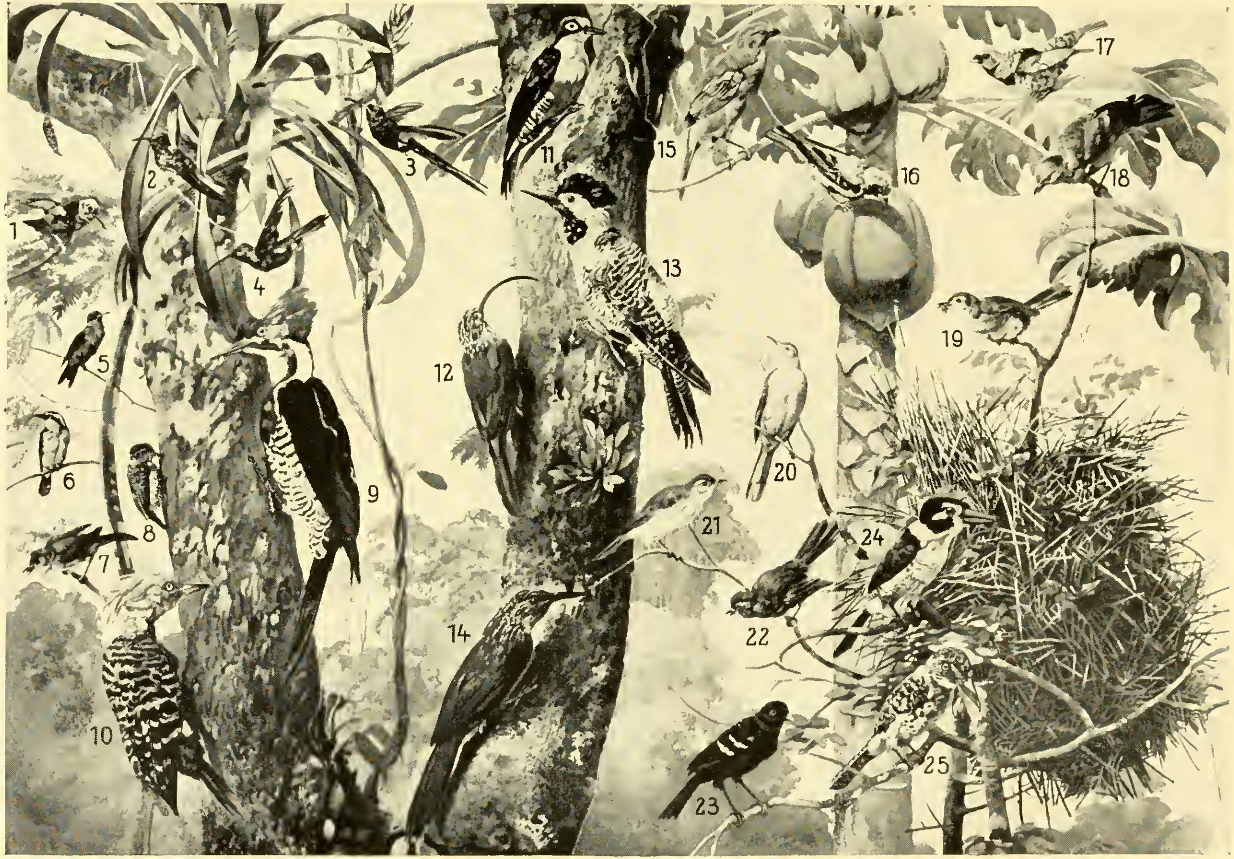
PLATE XXVIII

BIRDS OF BRAZIL

(1) Sugar-bird, Sahya zul (Cyanerpes cyaneus).—Humming-birds, Beija-flores: (2) Florisuga mellivora. (3) Eupetomena macrura. (4) Anthracothorax nigricollis. (5) Chlorostilbon aureiventris.—(6) Sebito, Cambacica, Mariquita (Certhiola chloropyga). (7) Hedge-sparrow, Carrixa, Corruira, Cambaxirra (Troglodytes musculus). (8) Lesser Woodpecker, Pica-pau pequeninho (Picumnus cirrhatus). (9) King Woodpecker, Pica-pau rei (Coeophloeus lineatus). (10) "Old Johnny," João velho (Celeus flavescens). (11) Woodpecker, Pica-pau (Melanerpes flavifrons). (12) Tree-creeper, Arapaçu de bico curvo (Xiphorhyncus falcularius). (13) Chãnchãn, Pico-pau do campo (Colaptes campestris). (14) Straight-billed Tree-creeper, Arapaçu (Dendrocolaptes picumnus). (15) Sanhaçu (Tanagra cyanoptera). (16) Sahy amarello (Calospiza flava) on a Mamão or Tree-melon. (17) Rainbow Tanager, Sahy de sete colores (Calospiza tricolor). (18) Sanhaçu coqueiro (Tanagra palmarum). (19) Curutié, Sacy pereré (Synallaxis cinnamomea) above its nest. (20) "Bundle-nester," João de pau (Phacelodomus rufifrons). (21) Green-let, Juruviara (Vireo chivi). (22) "Bundle-nester," Turucuhé, Ferreiro (Synallaxis ruficapilla). (23) Fire-eye, Papa taóca (Pyriglena leucoptera). (24) Sloth-bird, João bobo, Sucurú (Bucco chacuru). (25) Sleeper, Dorminhoco (Bucco maculatus).

Reduced reproduction of a coloured wall-picture, published by the author and the Companhia Melhoramentos (Gebr. Weissflog, São Paulo).

PLATE XXVIII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BIRDS OF BRAZIL

whole lithe body was washed over with a wonderful metallic lustre. Especially after moulting this snake was really astonishingly beautiful. He was very clean; his droppings were white and dry, and seemed to consist entirely of lime from the bones of his victims.

It was not easy to find suitable prey for the boa, and we had to invent various traps for rats and mice before he could be fed. Then all went well, and the boa was frequently given three mice in rapid succession. I had no trouble in getting him to eat. He took his meals in the dark; for the boa is a nocturnal reptile.

If I dropped a mouse into the snake's cage, the following drama was played: The prisoner scampered uneasily to and fro, scarcely noticing its dangerous companion, and finally sat in a corner and cleaned itself. Now the snake slowly and silently crept closer; his cat-like eyes sparkled, and his tongue darted out as though feeling its way. With a jerk the head assumed the proper position of attack. Now the mouse became aware of its peril; it ceased to move, sitting rigid and silent, not because it was "fascinated" by the snake's eyes, but because instinct told it that immobility might save it, since the reptile does not recognize a motionless quarry. So for some time the two creatures faced one another, the mouse in the corner, the snake in front of it, his neck retracted like a spiral spring.

At last the mouse grew tired of the comedy; thinking that the danger was over, it tried to escape; but at its first barely perceptible movement the snake lunged forward in a flash; the mouse was seized and snatched back, and in a moment the snake had noisily thrown two or three coils round it. One saw these coils contract twice or thrice; the black eyes of the mouse protruded, the whiskers quivered once or twice, and the victim was motionless: stifled in a few seconds, before it realized what was happening.

Now the narrow head of the snake, which had quite disappeared, emerged again, and wandered over his coils, seeking the victim's head. The boa uncoiled himself, and touched the mouse here and there with his tongue; an action which may have given rise to the legend that snakes beslaver their prey. It looked as though the boa was delighting in his booty; he rubbed his nose on the soft fur, and smoothed it all over, constantly touching it with his tongue, and even passed his open mouth a few times over the body. He seemed to derive a peculiar pleasure from touching the rosy little mouth of the mouse.

Now he pressed the still somewhat distorted body of the mouse straight, opened his jaws wide, and pushed them over the mouse's nose. He pressed his body closer to his booty; the mouth reached forward, right and left, until half the mouse had disappeared; then the snake lifted his head, and one saw that the neck was laid in coils, pressing the body down; the mouth remained open, since it had nothing to chew, and so the victim slipped down, until at last the tail disappeared as though of its own volition, so that it looked as though the mouse was voluntarily entering the dark gullet. At last all was over, except for several yawns, and the robber lay still, while in his body the swelling which marked the position of the mouse moved slowly backwards.

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The habits of the snakes are adapted to the habits of their prey. The Sucury, the Giboya, and the venomous snakes hunt mammals, and as these—and especially the smaller species—are nocturnal in habit, the snakes in question go about their business by night. The eyes of both these groups, with their long, vertical pupils, betray the fact that their visual organs are adapted to the darkness. But since their victims might quickly disappear in the darkness, they must somehow be prevented from making the attempt. The Sucury and Giboya prevent their escape by surrounding them with their coils; the venomous snakes by injecting their deadly poison.

The harmless snakes—with the exception of the Boas and Anacondas—have large, round eyes, adapted to use by day; their very expression seems to us innocent. The round eye, and the tail that gradually tapers to a sharp point, enable us at once to distinguish the harmless Coral-snake (Plate 31, 10, 11) from the venomous species. The latter (Plate 31, 12) has a fat, truncated-looking tail, and its eyes are very small, lest it should injure them while burrowing in the ground—in search, as a rule, of other snakes.

A snake which one often exhumes while excavating the nests of the Sauva ants is the "Two-headed Snake," the "Cobra das duas cabeças" (Plate 31, 8). This creature looks like a very large white earthworm. Because when alarmed it curls its tail up to its head, the Brazilian countryfolk believe that it has two heads, both of which are venomous, and that it bites first with one and then with the other. In reality the snake is perfectly harmless; indeed, it is not really a snake at all, but belongs to the Lizards; to a group which has lost its feet, like our Blindworm or Slowworm. Nevertheless it has been given a bad name, and has suffered under it, just as the harmless Gecko has suffered as a result of its popular name of viper, "Vibora."

The snakes which seek their food by day are not venomous; they have no need of venom, since their prey—consisting chiefly of frogs, toads, lizards and other snakes—has little chance of escape in the daylight. These diurnal snakes are often exceedingly beautiful. There is a whole series of green snakes, uncommonly slender and graceful, which writhe through the grass like flashes of emerald light. On my first day in Olinda I saw a glittering Emerald Snake (Plate 31, 3) in the garden. Another green snake, Philodryas olfersi, has a red streak down the back, and a black stripe across the eye; and a third has two yellow lines running the length of the body. These snakes, which are fond of climbing trees, feed on lizards.

Another Brazilian snake is the Liana Snake or Cobra cipó (Plate 31, 2). I found this snake in Seringal, Pernambuco. It deserves its name; it is long and slender as a liana or a whip-lash. More than six feet in length, it writhes so quickly through the bushes that one sees little more than a flash of its lustrous greenish-brown body. The round eye, exceptionally luminous, gleams like a topaz in the long, narrow head. The Liana snake eats frogs and toads.

The large toads of Brazil must constitute the diet of a number of snakes, and it is astonishing that they are nevertheless so plentiful. In the villages, during the rains, you may see them under the verandah steps, often several at a time, or hopping along by the walls. Even for large snakes they represent a respectable mouthful, and it was a horrible spectacle to see our Xenodon swallowing one of these toads in the monastery garden. It was often a full hour before the snake had pushed its jaws—no wider than two fingers—over the victim, which was as large as one's two fists, and the head at length disappeared with a few last notes of distress. But it must not be forgotten that in the snake the bones of the head, which in the other vertebrates are laminiform, constitute an open, articulated structure, so that the back of the head can be expanded until it will pass over an object of many times its normal circumference. The Xenodon snake, when alarmed, spreads itself out quite flat, till it looks like an empty skin surmounted only by a low crest.

A common Brazilian snake is the large Caninanha (Plate 31, 4); another common snake, handsomely marked with black and yellow, is the enemy of the poultry-farmer; and a third lives on lizards. The habits of all these non-venomous snakes are somewhat similar, so that I need say no more about them. But I must say something

Plate XXIX (I)

MIMICRY

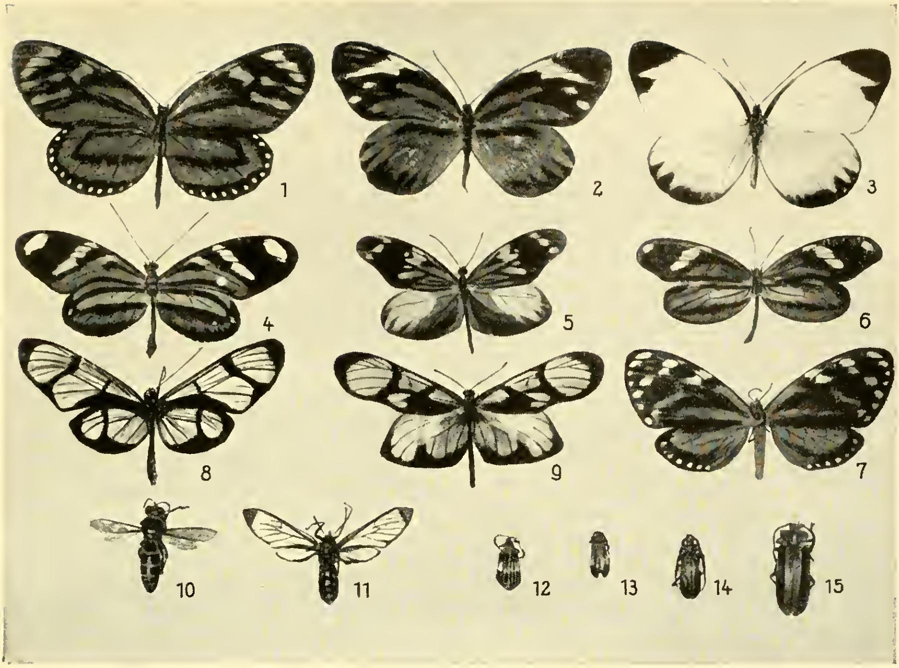
(1) The nauseating and little persecuted Heliconid, Lycorea atergates. (2) The female of Perhybris pyrrha, which mimics Lycorea, though the male (3) is a perfect Pierid, except that the incipient black and yellow mottling of the underwing is very faintly perceptible on the upper surface. (4) The nauseating Heliconius eucrate, imitated by (5), the Pierid, Dismorphia arsinoë, which still retains traces of white on the hind-wings, (6) Leptalis amphinoe, and (7) the moth Pericopis crescides, which flies by day. All these insects are coloured black, reddish yellow and bright yellow. (8) The nauseating hyaline butterfly, Methone confusa. (9) The Pierid butterfly, Dismorphia orisi, which mimics it. The tinge of white on the hind-wings is more or less concealed by the usually more retracted position of these wings. (10) A Wasp. (11) A butterfly, Isandra utriera, which mimics this wasp. (12) The black and yellow beetle, Calopteron bifasciatum. (13 to 15) Capricorn beetles which mimic the latter. Pteroplatys, Lophonoceras hirticonis, and Tropidosoma spencii.

Plate XXIX (II)

INSECTS WHICH MIMIC LEAVES AND TWIGS, AND SOME OTHERS

(1) Praying Mantis, a Locustid with green leaf-markings and a mildew-like patch on the fore-wings, which alone are visible in the nesting position. (2) Fore and hind wing of the Locustid, Pterochroza arrosa; the first showing perfect leaf-markings of green, brown and white, while the hind-wing shows a characteristic recognition-mark. (3) The Bark-bug, Phloea corticaria. (4) The Leaf-bug, Diactor bilineatus. (5) Stick-Weevil. (6) Cicada or Cigarra. (7) Larval form of same. (8) Lantern Beetle or Fire-fly, Pyrophorus noctilucus. (9) Perandra mandibularis, which fells trees with its mandibles. (10) The Palm-Weevil, Rhynchophorus palmarum. (11) The Giant Ant, Dinoponera grandis. (12) Sauva soldier. (13) Sauva queen. (14) A Hornet, Pepsis albomaculata. (15) A Fly which mimics it, but which has only two wings; beneath these are small balancers. (16) A Locustid Stick-insect.

Photographed from specimens collected and compared by the Author, and a few specimens from the Natural History Museum of Freiburg, photographed by Emil Engel, Freiburg i. Br. (*about one-half natural size*).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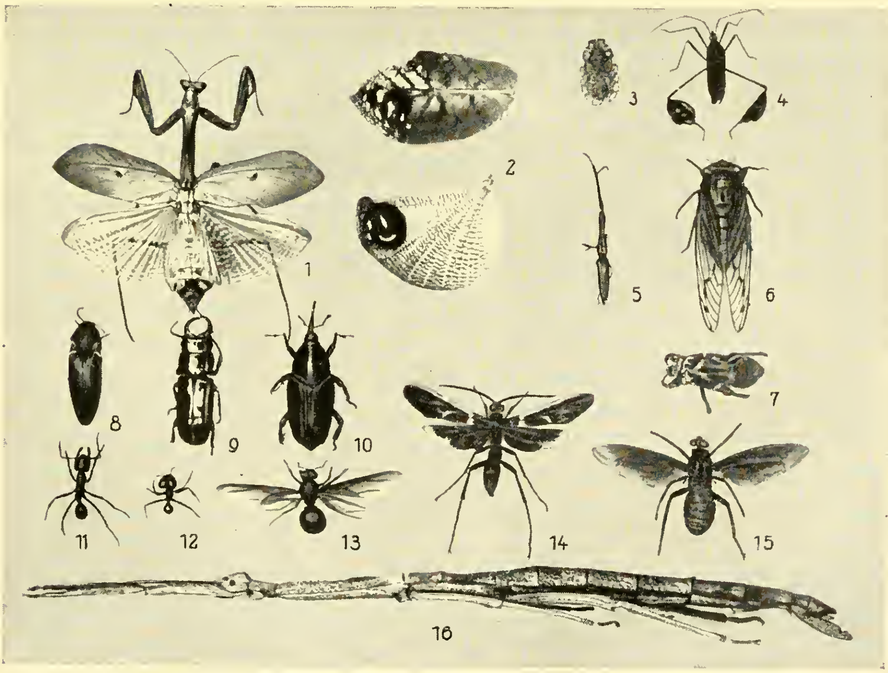
(I) MIMICRY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(II) INSECTS WHICH MIMIC LEAVES AND TWIGS, AND SOME OTHERS

of one more non-venomous snake: the Brazilian's eyes light up at its very name, and he cannot sufficiently praise it. This snake is the Mussurana.

The Mussurana (Plate 31, 9) is a very beautiful snake; its black scales have the gloss of lacquer, and each is surrounded by a white border; the whole reptile looks as though cast in bronze. But it is not for its beauty that it is honoured. The Mussurana is famed as an auxiliary in the campaign against the venomous snakes, and in particular the Jararacas. For this reason Mussuranas are kept at the Snake Institute of Butantan, of which I shall presently say something; and there, if a Jararaca is thrown to a Mussurana, one may see the latter immediately seize the venomous snake, quite regardless of its fangs; in wild confusion the writhing bodies lash to and fro; the Jararaca defends itself desperately but unavailingly; at every pause the jaws of the victor gain a surer hold (9), and presently only the tail of the victim is left protruding from the other's mouth. The Mussurana can find its prey anywhere; it knows at once if there is a venomous snake in its pen, and proceeds to drag its victim out of its hiding-place, or to pursue it if it attempts to climb.

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I have already said that the traveller in India or Brazil need not be constantly in dread of the fangs of venomous snakes. I will once more explain why.

In the first place, the venomous snakes, as one may tell by their cat-like eyes, are nocturnal reptiles; if one sees them at all by day they will be basking in the sun; but they are then uncertain in their movements, as they cannot see plainly; and I myself have found that a Rattlesnake, if one teases it with one's outstretched foot, usually misses the boot when it strikes.

Secondly, the boots worn by Europeans are a protection against venomous snakes; it would be an extraordinary thing if the snake's fangs should penetrate the leather. Even so, most of the poison would be wiped off the fangs as they passed through the sock, and only a remnant would enter the flesh. As a rule, the venom is deadly only if the snake bites the unprotected skin. But everything depends on the interval which has elapsed since the snake last used its fangs, or the amount of virus which has accumulated. Since the native peasants and field-workers always go about bare-footed, they have more reason to fear snakes. When they are working all day on the coffee-plantations in the hills, or in the forests of recent growth (capoeira), they may happen to tread on a snake, since these reptiles are often found hidden under the leaves on the quiet and sunny hillsides. Dr. E. Bethke, during one year's practice in Espirito Santo, saw or heard of ten or twelve fatal cases of snake-bite. He himself—having arrived in good time—treated thirty to forty cases with serum prepared at Butantan, and always with complete success.

Accidents happen, then, if snakes and human beings are not on their guard. We must get rid of the idea that snakes bite for the pleasure of biting, and that they will even seek for human victims, or run after them. All living creatures prefer to be left alone, and when approached by man their first impulse is to escape. As a rule, however, one comes upon a snake when it is rolled up in a flat coil, with its head in the centre: a position which does not facilitate rapid flight. If one walks round a rattlesnake when it is thus coiled up, the head constantly follows the enemy; a curious and rather uncanny sight. At the same time the snake sounds its shrill rattle in warning. Even this rattle shows that the snake prefers to give warning rather than bite. The rattle consists of a varying number of telescoped rings on the tip of the tail, which, when the rattle is sounded, is lifted and quickly shaken to and fro, when the rings grate on one another and produce the characteristic sound. The Jararaca too shakes its tail to and fro when excited, and if it is surrounded with dry leaves, as is commonly the case, a warning sound is produced which is very like the rattle of the rattlesnake.

Every snake has its individual temperament; and it is important that one should understand this, as the degree of danger depends upon it. In Ceylon the extremely venomous Spectacled Cobra was not so greatly dreaded as the Tik Palonga, a viper six feet in length. The latter is extremely nervous, is easily startled, and will then bite at once, while the Spectacled Cobra has a quieter temperament. It is fond of entering houses—indeed, a Cobra once visited me in my bedroom—and will even creep into bed, being a lover of warmth. But its human bedfellow is not therefore doomed to death; one may even kick the snake without being bitten. I kept some Spectacled Cobras for a long while in Ceylon, and convinced myself of their placidity. It is precisely this quality which has made them the favourites of the fakirs. If one quietly takes hold of the snake one can place it in a basket. For that matter, the explorer De Grijs was able to do the same thing with the venomous Coral Snake of Brazil. Only sudden and irregular movements alarm the reptiles. I once learned

TERMITES' NEST ON THE LAND OF THE AGRICULTURAL COLLEGE, TAPÉRA

SAGUIM MONKEY

DRAWING VIRUS FROM A RATTLESNAKE, BUTANTAN INSTITUTE

in my own person that it is always well to keep one's head. In Olinda one evening I slipped my bare feet into my slippers and went over to the washstand, when I felt something nibbling my foot. At first I took no notice of it, but when I began to wash myself it spread over all my toes, and on my drawing off my slipper to see what was the matter, a long millipede, as thick as my finger, ran out of it. Had I torn off my slipper in alarm the creature would have bitten me, and a Scolopendra of this species is venomous.

The last and best insurance against the dangers of snake-bite in Brazil is the Butantan Institute. This Institute is one of the principal sights of São Paulo, and is much visited. One takes the "Bond" at the Praça da Sé, from which all the electric trams start, and rides through streets bordered with low houses and shaded by Grevilleas, privet trees and cedrellos. The tram stops at Pinheiros, a suburb with a dusty market-place surrounded by houses in the course of construction, and the journey is continued in a cab. Now the landscape grows more beautiful; the meadows beside the road are bounded by hills, and by the wayside the Brazilian ragwort blooms yellow, the Brazilian broom puts forth its triangular shoots, and the vervain uplifts its spires of pretty blue flowers.

A door opens, and we are in Butantan. A pretty botanical garden covers the gently undulating ground; here are glass-houses and laboratories and a fine herbarium. The Institute itself is a white building with laboratories and a museum in which one can study all the snakes and their enemies.

But the most singular thing about the Institute is the open space before the entrance. A low wall, behind which is a running stream, surrounds a lawn from which rise domes of Portland cement, which are intended to represent termitaries, for these, in Brazil, are the favourite refuge of the snakes. And before these grey domes the brown venomous snakes are lying, large and small, many of them moving about. The largest venomous snake of Brazil, the Surucucú, 13 feet in length (Plate 31, 17), is rarely to be seen, but here are the Jararaca (16) with the dark horse-shoe markings on its flanks, the Labaria (14), also known as the Jararaca, the finely ornamented Urutú (13), the sharp-snouted Cotiarinha, the Golden Urutú, with handsome boa-like markings, the Lachesis (19), and above all the Rattlesnake or Cascavel (18), its body marked with beaded lozenges. Now one of the officials climbs the wall and crosses the water, and with a hook pulls other snakes out of their dwellings, until at last they are swarming at his feet. He grasps a rattlesnake, lifts it up, seizes its head, and presses its cheeks together (Plate 30), so that the venom trickles from the fangs into a bowl held beneath it. This virus is injected into horses, in gradually increasing doses, until they become immune, when a serum is prepared from their blood. There are special sera—for example, rattlesnake serum—and a mixed serum with which any snake-bite may be treated. One carries a phial of this serum on one's travels, and a small hypodermic syringe. If one is bitten by a venomous snake one injects a little serum into the skin round the wound, or between the wound and the heart, and one may then be sure that no serious results will ensue. The Butantan Institute is therefore a national blessing.

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Much more unpleasant than the venomous snakes, and beyond comparison more dangerous, are the bloodsucking insects of Brazil. If I am asked what dangerous creatures there are in India and Brazil I do not speak of the tigers, leopards, jaguars and snakes, but only of the mosquitoes. These are the enemies which one really has reason to fear in the tropics, for they are the carriers of malaria, and the still more dangerous yellow fever.

But here again the reader must not be too greatly alarmed. One thinks of mosquitoes as particularly formidable insects. As a matter of fact there are plenty of mosquitoes in Europe. The species that carries malaria may be found in Baden. When the disease itself is not prevalent the mosquitoes cannot convey it, and are therefore harmless. But when during the war malaria was introduced into certain war prisoners' camps from South Russia, malaria made its appearance here and there among the people of Baden, as I saw with my own eyes.

The conveyance of malaria is effected as follows: In the blood of a malarial patient live millions of tiny living creatures. These make their way into the red corpuscles of the blood, multiply therein, and wander off into other corpuscles, while the corpuscles thus attacked are decomposed, so that each time the parasites multiply the patient has an attack of fever. If the malarial mosquito bites a person suffering from malaria, it sucks in the parasites together with his blood, and these become encysted in the wall of the insect's intestine, and presently their offspring find their way to the salivary glands of the insect. With the saliva of the mosquito, which the insect injects into the wound in order to prevent the blood from coagulating, the malarial parasites enter the blood of a healthy person, and make their way into the red corpuscles, and he too falls ill of malarial fever.

In order to be inoculated with malaria the mosquito must first bite a malarial patient, that is, malaria must exist in the neighbourhood. But this is by no means the case all over Brazil, so that thousands and thousands of Brazilians are bitten by mosquitoes without falling ill. And it must not be supposed that mosquitoes are a pest only in the tropics! Neither in Ceylon nor in Brazil have I suffered from mosquito-bites as I have done at Karlsruhe or in Alt-Breisach. In Brazil I encountered whole swarms of mosquitoes only in Ribeirão; at night they hummed round my bed, but I spread the mosquito-net which I always carry with me over my bed, and I was not bitten. One should always have a mosquito-net at hand in Brazil, except perhaps in the large towns and the mountains, for one is in greater danger of mosquito-bites at night, since the malarial mosquitoes do not begin to bite until it is dark. My good mosquito-net served me well when I was in southern Pernambuco, in a bad malarial district, for quinine prophylaxis (fifteen grains every Friday, and half as much on Sunday) is not certainly effective unless one continues it for six months after leaving the malarial region.

Worse than malaria is yellow fever. This is conveyed by a mosquito speckled with black and white, which has a dark triangle on its back. This insect is given to biting as twilight falls, and, as Dr. Lutz observes, is both shy and importunate. Yellow fever, which is generally fatal to Europeans—two German ladies died of it while I was in Pernambuco—was formerly the scourge of Brazil, especially in the seaports, and at one time in Santos the sailors could escape death only by taking the train directly they landed, and going to a sanatorium in the mountains, returning only after their vessels had been laden by natives, whereupon they went aboard and weighed anchor. New-comers were particularly liable to the worst form of the disease. The business men of Rio had discovered that they remained in health if they only worked in Rio, and went to Petropolis to pass the night. The embassies too established themselves in Petropolis.

It is owing to Dr. Oswaldo Cruz that Rio and Santos are to-day free from yellow fever, and that only isolated cases occur from time to time in the northern ports. Actual epidemics are things of the past. Dr. Cruz accompanied the campaign against the fever by a campaign against the mosquitoes. To-day his work is still carried on in the Oswaldo Cruz Institute, which looks over the bay from one of the suburbs of Rio: a fine building in the Moorish style. Throughout Brazil, moreover, an *Assistencia publica* has been organized, and in each State there is a Department of Hygiene. I saw in Olinda how carefully and thoroughly the foci of infection were attacked. The infected house is at once marked by a yellow flag, which means that no one may enter it. It is then, with the neighbouring houses, completely covered with great linen cloths—in the case of one-storied houses this is possible—and is then "gassed" with poisonous vapours, so that all the mosquitoes are killed. Every day, moreover, officials visit all the houses in that quarter of the city, in order to drain any accumulations of water, or to disinfect them, or place small fish in them; these are a species of carp, which will live even in the smallest puddles, and devour the mosquito larvae. In the monastery these fish were placed in the cistern on the roof which supplied the house with water. And it is the law in Rio that every garden pond or stream must contain fish.

When I travelled by the electric tramway from Recife to Olinda, through the mangrove swamps, the hands and faces of the passengers wer sometimes covered with tiny black flies, which sucked their blood and gave rise to an unpleasant irritation. The Brazilians call these flies, which are no bigger than a pin's head, "Maruim" or "dust." We have just such midges in Germany. Their larval state, like that of the mosquito, is passed in the water.

I never suffered while in Brazil from the gadflies or Motucas. In some parts these buzzing flies are said to make themselves unpleasant. One species of gadfly, the "Bicho berne," is greatly dreaded. Its eggs are deposited not only on the hides of cattle, but also on the skin of human beings. From these eggs maggots emerge, which grow and feed under the skin, while a large boil forms over them. When the maggots turn in the wound which they have made they are said to cause acute pain. Dr. Bethke, a physician of Espirito Santo, assured me that the people extract the maggot by laying a piece of bacon on the place; it eats its way through this, as it can no longer obtain any air. At a later stage the maggot bites its way out in any case, falls to the ground, and pupates. It is a remarkable fact that these flies do not lay their eggs directly on their victims, but on the necks of other flies or mosquitoes. These rub them off on men and animals, who receive the parasites without knowing how they arrived. Many gadflies convey disease. In the interior of Brazil donkeys and other draught animals suffer from a lameness of the hip-joint, known as "Peste de cadeiras," which is conveyed by gadflies. Blowflies lay their eggs on sick, wounded and dying animals, and the maggots increase their sufferings. Human beings also suffer from infections carried by maggots, especially an infection of the nose, known as myasis.

In the Sertão I was warned that I might have a nocturnal visitor, but it did not appear. This was a large black and red spotted bug, the Barbeiro, compared with which our European bed-bug is a harmless insect. The latter, imported from Europe, is said to infest many houses in southern Brazil; in Pernambuco I saw one only. The Barbeiro is said to give a very painful bite, and to withdraw a considerable amount of blood. Another species of bug conveys a dangerous disease, known as Chagas' disease, after the physician who discovered its cause. In his campaign against the Barbeiro man is assisted by another species of bug, whose larva covers itself with dust and dirt, and in this mask of dirt creeps up to other insects, seizing them unawares and devouring them.

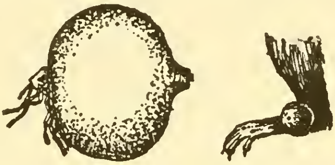


FIG. 39.—Female Sand-flea or Jigger (*enlarged*). Beside it, the natural size, the foot of a mouse with sand-flea under the skin. (*After Karston*)

Strangely enough, I never saw anything of two other bloodsuckers, of which many travellers, and more particularly naturalists and explorers, have painful experience. One of them is the tick, or Carrapato, which is related to the spiders; it lurks in the bushes, and being brushed off on to the skin, it sinks its proboscis in its victim's flesh, and sucks his blood until its body swells to the size of a pea. There are also certain red ticks, known as Mucuim or Muidos, which are so small that one simply cannot extract them, and is forced to bear the irritation until they take their departure or die. Many wooded districts are so full of ticks that the traveller is quickly covered with them, as though with a pustular eruption.

A troublesome inhabitant of Brazil is the Sand-flea, Bicho de pé or Jigger (Fig. 39). The fertilized female of this insect bores into the feet of human beings, its favourite spot being under a toenail; at first it is hardly visible, but gradually its abdomen grows to the size of a pea. Its presence first makes itself felt by the intolerable itching caused by its digging and bloodsucking activities, but if the Sand-flea is not at once extracted inflammation and suppuration ensue, which may necessitate the amputation of the toe, or may even have fatal results. From Brazil the Sand-flea has been exported

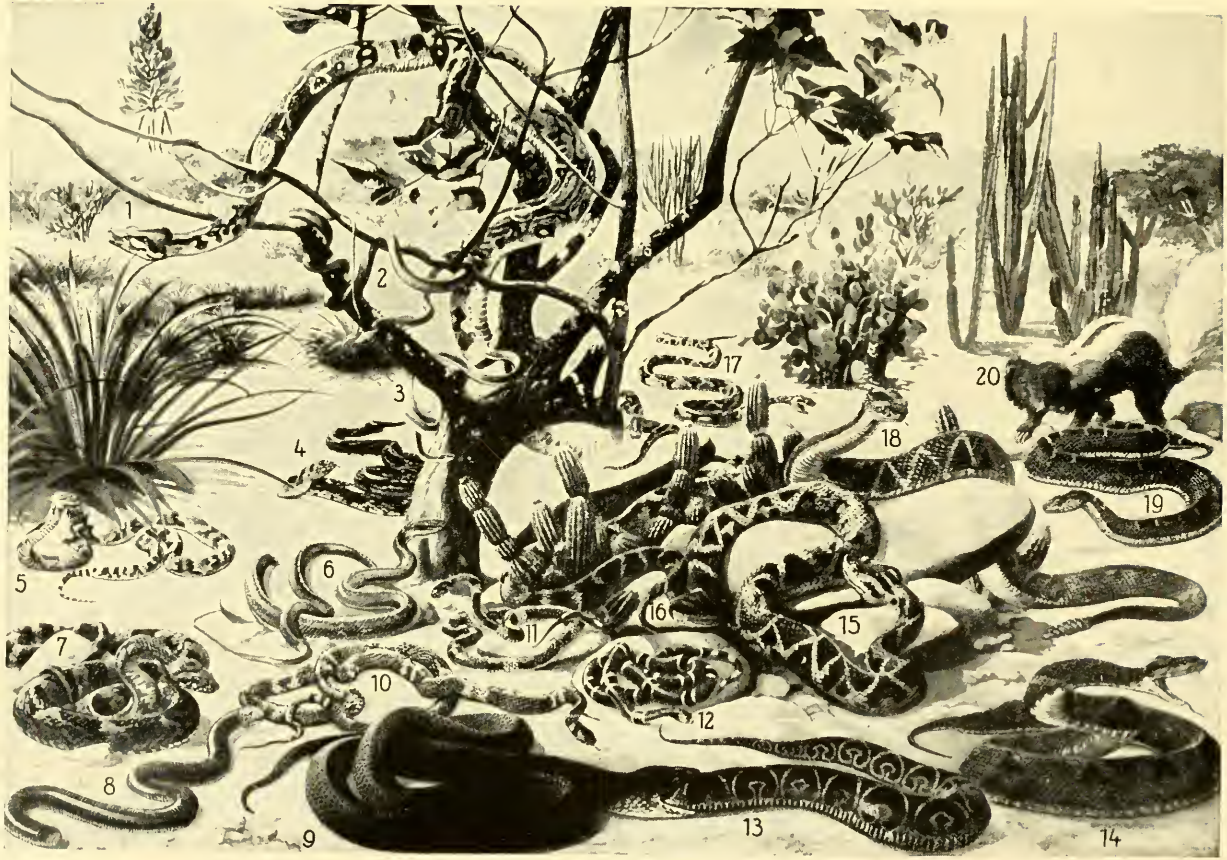
PLATE XXXI

BRAZILIAN SNAKES

(1 to 11) Non-venomous Snakes. (1) Giboya, Cobra de veado (Boa constrictor), attains a length of 20 feet, while the Anaconda, or Sucury (Eunectes murinus), a water-snake, is sometimes over 25 feet in length. (2) Liana Snake, Cobra cipó (Herpetodryas carinata), over 6 feet. (3) Emerald Snake, Cobra verde (Philodryas aestiva), 5 feet. (4) Caninana (Phrynonax sulphurea), 6 to 10 feet. (5) Toad-adder (Xenodon Meremii), 6 feet. (6) Green Snake, Cobra verde (Philodryas Olfersi), 5 feet. (7) Cobra nova (Drymobius bifossatus), over 6 feet. (8) Two-headed Snake, Cobra das duas Cabeças (Amphisbaena alba), 20 inches; belongs to the lizards. (9) Mussurana (Oxyrhopuscloelia), over 6 feet, eats venomous snakes; here it is seen devouring an Urutú. (10) Coral Snake, Cobra coral falsa (Erythrolampus Aesculapii), 40 inches. (11) Coral Snake (Oxyrhopus trigeminus), 40 inches. (10 and 11), which mimic the black, red and yellow colouring of the venomous Coral Snake, are dangerous to small animals, but not to human beings. They may be recognized by their large eyes and pointed tails.) (12 to 19) Venomous Snakes: (12) Coral Snake, Cobra coral (Elaps corallinus), 28 inches. (13) Urutú, Cotiára, Cruzeiro (Lachesis alternatus). (14) Jararaca, Labaria (Lachesis atrox). (15) Jararacuçu (Lachesis jararacussu). (16) Lance-snake,Jararaca (Lachesis lanceolatus). (17) Surucucú (Lachesis mutus). (18) Rattlesnake, Cascavel (Crotalus terrificus). (19) Jararaca do rabo branco (Lachesis Neuwiedi). The venomous snakes may reach a length of 6 feet or more; only the Surucucú [17] attains a length of 13 feet.) (20) Skunk, Surilho, Cangambá (Conepatus chilensis), which eats venomous snakes, regardless of their bite.

Reduced reproduction of a coloured wall-picture, from *A Fauna Brasileira*, published by the author and the Companhia Melhoramentos (Gebr. Weissflog, São Paulo).

PLATE XXXI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BRAZILIAN SNAKES

to West Africa, and in the course of twenty-five years it has spread over the whole continent, reaching even the East Coast; and on Lake Victoria Nyanza whole villages were depopulated by this horrible pest, for which the natives could find no remedy. The insect lives in the dust of houses and streets. Once its presence has become perceptible, it is best—or so I was assured in north-eastern Brazil—to get a negro to extract it. The negroes use the long knife which they always carry, employing it as a weapon, a table-knife, and a toothpick, and with the greatest dexterity they cut the insect out of the toe.

Travelling through Pernambuco, and also in other parts of the interior of Brazil, one often sees people standing about the railway-stations whose bloodless faces, jaded bearing and fatigued expression are at once conspicuous. These people are suffering from a malady very common in Brazil, and which, after syphilis, is doing more than any other to undermine the health of the nation. The extirpation of these two diseases is the most important, but also, perhaps, the most difficult problem before the country, and one that must be solved if its future is to be prosperous.

This disease, which in Brazil is almost a national pestilence, is caused by an intestinal parasite, the hookworm. It is about two-fifths of an inch in length, and it anchors itself, with its formidable teeth, to the mucous membrane of the small intestine (Fig. 40). This worm absolutely eats its way into the wall of the intestine, which, being wounded by its teeth, begins to bleed, and it is to this constant loss of blood that the pallid complexion of the sufferers is due. It seems, however, that certain toxic symptoms of the disease are caused by the juices which the worm injects into the wound.

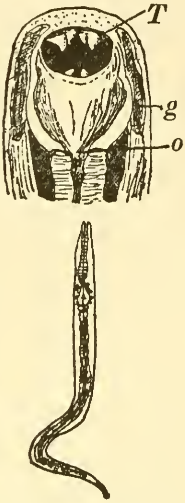

Fig. 40.—Head of Hookworm from human intestine. T, teeth, *o*, oesophagus; *g*, glands. Beneath, the larval state, showing gut and elongated sacs, the rudiments of the generative organs

The eggs produced by the female hookworm reach the outer world in the dejecta, and develop in the moist soil. From the soil the tiny larvae (Fig. 40) may find their way back into the mouth; and this is especially possible in the case of persons whose work brings them into contact with the soil, as, for example, the men employed in boring the St. Gotthard tunnel, who, like the Westphalian miners, suffered severely from the hookworm disease. Cleanliness of the hands, particularly before eating, is therefore the surest means of avoiding infection. But it has been discovered that the larvae can bore their way through the pores of the skin, reaching the intestine by way of the blood-stream. Bare feet—so common in the interior of the country—will afford the larvae an opportunity of penetrating the skin. Water should never be drunk unless it has been boiled—especially as typhus prevails in many parts of Brazil.

There are also certain microscopic worms which, like the malarial parasites, are injected into the blood of human beings by mosquitoes. There they multiply enormously, giving rise to terrible abscesses and monstrous swellings of certain parts of the body. This disease is known as filariasis or elephantiasis. Persons afflicted with filariasis often join the lepers, with their eroded faces, in the railway-stations, thrusting their hands in at the windows of the carriages and begging for alms: a terrible spectacle.

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I must say something of one more South American bloodsucker. Even in the Middle Ages news of its existence reached Europe, and excited people's imaginations to such purpose that they saw in it the embodiment of a phantom of whose terrible deeds they had read in ancient legends.

Who indeed would not shudder if he was told the following story? A man lies sleeping in bed; suddenly, through the open window, a huge bat enters on soundless wings. It flies along the walls, rising and falling, in ever-narrowing circles; now it settles on the sleeper's breast, fanning him softly with its grey wings, while its teeth bite through his skin. The fanning cools the wound, and the gentle draught lulls the victim into sounder sleep. When the creature has drunk its fill it rises into the air, flies out of the window, and disappears into the night.

In this form the story of the vampire made its way all over the world; and although the statement that the bat fans its victim has not been confirmed, so many travellers have asserted that they have been bitten that one cannot doubt the existence of the bloodsucking bat. I myself saw vampires in Olinda; they even came into my room, but they could not have bitten me, even had they wished to do so, as I slept under a mosquito-net. On the other hand, they did draw blood from the backs of the donkeys in the stable; the wounds were visible in the morning; and two vampires were shot and brought to me whose stomachs still contained blood.

As I have told in another chapter, I was always glad to see the bats which came to my room to eat the cockroaches. They were not, of course, so numerous as those which Bates saw at Para, where the swarms of bats literally filled the air of his room and extinguished the lamps. At night the traveller was awakened by the bats that were creeping all over his body, filling his hammock; he caught as many as he could, and flung them against the wall; nevertheless, in the morning he found a bite on his hip.

Other travellers too have told of bites on the throat, the breast, the hips, or the toes. But these were always small and benign wounds, and according to those best entitled to judge, the amount of blood subtracted from horses and other domestic animals is not such as to injure their health. According to the most recent information, the bats which suck blood—that is, the Leaf-nosed Bats—are only occasional bloodsuckers, their usual diet consisting of insects and fruits. There are ninety species of bats in Brazil, which, by the extermination of mosquitoes, the fertilization of certain flowers which have adapted themselves to their visits, and the propagation of fruit-trees, whose seeds they sow after eating their fruit, make themselves so useful that one must not allow oneself to be prejudiced against them by the few occasional bloodsuckers among them.

XX

THE BRAZILIANS

From my very first days in Brazil until my departure I always felt at home in the country, and when, on returning from the Argentine, I once more went ashore at Santos, and wandered at will through the warm, fragrant air of the tropics, under the palms and banana-trees, and between the pretty gardens and the pleasant houses, meeting cheerful human beings of every shade of complexion, I knew once more such a pleasant, comfortable feeling as when one revisits intimate friends with whom one has lived as though in one's own house.

And how comfortably I lived, even in Brazil! In my room in the monastery of Olinda I sat at ease in my rocking-chair, book in hand, cooled by the gentle breeze that blew from the luminous green ocean, which ever and again attracted my gaze. Slowly the great, glittering crowns of the coconut-palms waved against the blue sky, and with silent, gliding flight the black vultures passed over the garden.

In the Benedictine monastery at Rio I lived in a lofty cell with a cross-vaulted ceiling. The great foursquare building rose from a steep headland that ran out into the bay, so that as one wandered along the wide verandah one could look out in three directions over the bay with its islands, and the vessels entering and leaving, and the picturesque girdle of beautiful mountains, until the sun sank, and the coloured signal-lamps began to glow, while beaded strings of light began to creep along the curves of the waterfront.

Inside the monastery a broad cloister, with its great pillars and arches, surrounded a green garden of palm-trees in which the orange plumage of the ibises glowed like flowers. A contrast to these two old monasteries was offered by the modern "São Bento" in São Paulo. The great façade, with its calm, rigid outlines, rises from the busiest square of the city. At the back of the building is a ravine, across which a viaduct flings its arches. All is airy and modern; the gymnasium which has been built on to the main fabric is bright and sunny, and is even provided with a swimming-bath. But the whole is dedicated to the service of the church, with its wall-paintings and its magnificent organ. The constant proximity of the church, which is an organic part of the monastery, and is, so to speak, the beating heart of the foundation, makes a stay in São Bento an intimately moving experience.

But I often stayed in private houses also, and my longest visit was to the house of a fellow-German and his Portuguese wife, who lived in Rio. From the rooms of this house one walked into a great garden, which ran down a steep slope, and between the great green leaves of the trees and bushes of the garden shimmered the blue waters of Guanabara Bay. Here, while working on the lawn, I had only to look up to delight my eyes with the sight of the many-hued butterflies or the glittering humming-birds. And in Pernambuco and Parahyba I was often a guest in private houses. I stayed with friends in the small country towns, with the manager of a cotton or sugar factory, or with the owner of an *engenho* or *fazenda.* As a pleasant climax to all this profuse hospitality I spent six weeks in the spacious home of a medical friend in Buenos Aires.

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The more primitive the houses in which I stayed, the less influenced by European civilization, the more interesting I found them. The hospitable manners of the old chivalrous Portugal were best preserved in the tropical North-east, where they have blended with the equally famed hospitality of the ancient lords of the land, the Indians. In the quiet, free, unconstrained life of these parts of Brazil, far from the bustle of modern life, the old customs have preserved a youthful vitality which must always be attractive to a guest.

In the airy dining-room I would sit in lively conversation with the master of the house. On my left stood a negro girl, whose duty was to change our plates; on my right the lady of the house. She did not eat with us, for she was fully occupied in preparing my food for me, in removing the bones from the fish and game, in selecting the best cuts, and when I had finished one dish, in offering me the next. Since in Brazil it is usual to eat three meat courses, followed by sweets, fruit, and cheese with marmalade, and ending up with black, sweet, fragrant coffee, one is in no danger of going hungry. I always found the food most appetizing, for in the old-fashioned Portuguese household there is invariably an excellent cook. The country, too, offers a rich abundance of food: a wealth of delicious fruits, lobsters, great prawns, game, and so forth. Sucking-pigs are much appreciated, and of feathered game the "Peru"—that is the turkey—holds the first place; it is commonly served with bacon

A national dish consists of a fowl cooked in its own blood, the meat thereby becoming black. I have already mentioned the *feijoada*, a stew of beans.

I always admired the Brazilian housewife when confronted by the arrival of a number of guests. When I was travelling with the Secretary of State in the interior of Parahyba, I found two acquaintances in the train, whom I introduced, and who were invited to accompany us. They accepted the invitation, but remarked that they were expecting to meet two friends at one of the next stations. These two were invited to join us, and when at last we reached the house of the young manager and his wife there were eight of us, and we stayed for several days. In Brazil it is a simple matter to put people up for the night. One is at first surprised to see two great hooks hanging from the walls in each corner of every room, and even in the drawing-room. They are not ornamental, but they serve a useful purpose, since by means of these hooks hammocks may be slung in the corners, so that a large number of guests can be accommodated. At dinner the housewife goes from chair to chair, or sits in her own chair, filling the plates, which are then carried round by negresses. In many houses the whole black staff of the kitchen stands in the doorway, listening contentedly to the conversation, and watching the diners without any feeling of envy; in others, people even come and lean over the window-sills, neither asking for anything to eat nor receiving anything, but joining in the conversation. Who or what they were I was never able to make out.

There is something free and unconstrained in the Brazilian's hospitality which sets the guest at his ease. My friends in the city were often visited by relatives while we were at table; they settled themselves in the rocking-chairs and joined in the conversation. They were free to eat with us if they chose; that was regarded as a matter of course; there was no invitation, and no compulsion; each did as he pleased. I myself was welcome in this house at any hour; I could eat with my friends, or go into the garden, or play the piano, or tilt myself to and fro in a rocking-chair and read; in short, they allowed one to do as one pleased, and thereby exercised the pleasantest form of hospitality imaginable.

I used often to visit a Brazilian lady in whose house I felt thoroughly at home—her son had made the passage out with me. On my first visit I saw a coloured servant stirring maize porridge over a coal fire, and learned that the stirring must be continued, without interruption, for an hour. I marvelled at the endurance of the old negress, who had been in the house since the days of slavery. When I returned to the house after a walk by the sea, I found in my room a plate containing a sample of this porridge. And often, if I took part in any festive gathering, flowers were sent to me afterwards, or the best fruits were picked for me, so that I realized that the true Brazilian puts his heart into his hospitality, and is always thinking of what he can do to give his guest pleasure.

This hospitality, indeed, is exercised even by people who according to our lights have no reason to show it. When I travelled by the electric tramway from Olinda to Recife, and wished to pay my fare, the conductor not infrequently informed me that it had already been paid; and when I asked him who had paid it he replied that it was paid by a gentleman sitting behind me, who had already got out. The Brazilian who on entering a train or railway-carriage sees an acquaintance sitting in front of him, or one whom he knows to be—as I was—a guest of his country, has the courtesy to pay this passenger's fare with his own. Even in the cafés my check was often paid in this way, though I never knew who paid it. A Brazilian would not think it becoming to light a cigar in a railway-carriage without offering one to his neighbour.

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When I asked myself why I found these manners so pleasant, it seemed to me that they reminded me of the old days in my own Fatherland, before the haste and bustle of to-day had come into being, and when there was more room to move, so that such customs were still possible. To live in Brazil was like living again in the Germany or the Europe of a century or two ago!

Then with us too people had more leisure; life was not so noisy and insistent in its demands, and the individual had not yet become a mere cog-wheel in a great machine, unable to do much more than reel off the work allotted to him.

In Brazil—and I am referring here to those regions that are somewhat remote from the large centres which are in touch with Europe—a man is something more, even in the eyes of the Government, than a profession, or perhaps even a mere title. He is valued as a personality, and his subsequent position, even if this be official, depends very largely on whether his is a congenial character. It was characteristic that when I received my appointment (as I was later informed) some anxiety was expressed as to whether or not I was married. In Brazil one simply has to be married; otherwise one would be regarded with suspicion; people would think that there must be something amiss! In this respect I was able to fulfil my hosts' expectations; but not, unfortunately, in another. At my age a Brazilian is not only married, but has ten to sixteen children! Here again old-world conditions prevail.

High officials are not addressed as "Privy Councillor" or "Excellency," but by their Christian name and the title of Doctor. The use of the Christian name is general; a pleasant custom, for which I have always envied the Russians, though they, of course, add the father's name. In Pernambuco even the directory gave the Christian names in alphabetical order. These are susceptible of greater variation and more individual than the family names, and are so chosen that they are not constantly recurring. I, of course, was Dr. Conrado, and was always so addressed by planters, officials and others, even on first acquaintance. If I went up the great public staircase into the Government palace of Recife, I was free to enter unannounced the room of the Secretary of State, whose doors, like its windows, were always open. Behind his great desk sat the Secretary; I myself sat down on a sofa, which, as a rule, already had one or more occupants; coffee was served, and sooner or later one was able to sit behind the desk by the Secretary's side and discuss one's business with him. I often had occasion to admire the uniform courtesy extended to one and all; this is a trait in which the Brazilian is incontestably superior to the European. Even to the beggar, if one cannot or will not give to him, one must apologize with a "Desculpe" (Excuse me!). An acquaintance told me that he was once talking to a beggar in Spain, when the man suggested that they had better not stand in the sun, but go into a café. There, however, the foreigner was not permitted to pay for the beggar, or even for himself: to do so would have offended the beggar's sense of honour.

The Brazilian is more sensitive and emotional than the European, and the ill-success of diplomatists and persons who have a mission to fulfil or wish to form connections in Brazil may often be explained by their ignorance of this peculiarity. I know of many cases in which a too openly displayed frigidity has meant failure to achieve the ends desired. No South American will put up with superciliousness or arrogance, and such qualities are quite out of place there. I have known many men of sterling worth in Brazil, whose hearts were full of kindness, and to whom envy and falsity were unknown; more particularly, indeed, among the simple countryfolk. In South

Pernambuco I was once three days in the company of a peasant-farmer. He reminded me constantly of a knight or *fidalgo* of old, with his noble features. His manner of expressing himself, and his ideas, were in harmony with the outer man. Each day we ate our lobsters together, and drank our coconut milk, and our farewell, accompanied by the usual Brazilian embrace—the Brazilians lay their arms round one another's shoulders and pat one another on the back—was genuinely cordial. The unspoiled humanity which one so often encounters in Brazil is one reason why one always feels a certain longing to return thither.

The Brazilian has a great love of liberty; he will stand no infringement of his rights, neither will he put up with insolence. This is true even of the children. Corporal punishment of children is unheard of, and one can see that it is never administered. There are children in Brazil of incomparable charm and lovableness and grace; but they are, of course, more serious and precocious than European children. The careless effervescence of youthful energy, the joy in childish games, the confidence of our European children, all of which often survive even in maturity, are much rarer in Brazil. In many respects—for example, in their dramatic talent and their skill in reciting—even the youngest Brazilian children are truly astonishing. Expressive movement is of course natural in a country where speech is so often supported or even replaced by gesture. No Brazilian schoolgirl would recite a poem without appropriate gestures.

Even the students of the School of Agriculture would suffer no hard words, as a new teacher once learned to his cost, for he came near to ruining the college. There was an army officer on the staff of the college, who had to train the students as reservists during their course. Even he addressed them always in amiable terms, as a comrade; and there was a delightful scene when the students left on the completion of their training; the flag before which the reservists took the oath of loyalty was held—a characteristic touch—by a beautiful girl. The Brazilians are highly patriotic. The flag is always saluted with uncovered head; all stand when the National Hymn is played, and it may be played only on solemn occasions.

Another beautiful trait is the family loyalty of the Brazilians. Poor relations are taken into the Brazilian home without hesitation; reverence is paid to parents, and the young people kiss even an uncle's hand. Young girls are the object of special veneration, and this gives them a more confident and friendly bearing towards the other sex, which heightens the charm of the essentially attractive, often extremely pretty, and always graceful young creatures. It is, of course, a general practice to heighten the complexion with artificial colour, and in the train from São Paulo one morning, as the dawn was breaking after an all-night journey, I was able to witness this process, and no one seemed to take exception to my presence. In Brazil women have a better opportunity of dressing becomingly than in Europe, as the climate always permits of thin clothes and light colours, which suit their graceful figures. The "Cariocas," as the ladies of Rio de Janeiro are called, are even able to leave their houses in bathing-costume and cloak, and walk through the city, or ride in the trams, and enter the water of the bay at some suitable spot. The Brazilians are extremely decent when bathing, even in the most secluded neighbourhoods; as regards the children this virtue is sometimes carried almost to excess.

It is an old custom that a young man may not enter the house of his beloved until he is betrothed to her; before this they may converse over the garden hedge, but only at a becoming distance. I was touched to see that even the servants follow this custom. The black cook of one of my hosts received her admirer every Sunday afternoon. The two conversed for hours, but she stood always three yards inside the hedge, and he three yards outside. A lady who had for years been a governess in the north of Portugal, where similar customs prevail, told me that she once asked a lovable old gentleman why he had never married. "I am hoarse," he replied; and when she gazed at him in astonishment, he explained: "Yes, the lady I loved lived on the third floor, and she could not hear what I said from that height."

Another most attractive characteristic of the Brazilians is their quietude. People often scoff at the *paciencia* of the Brazilians; and in business life the prevalent use of this word may indeed have unfortunate results. For myself, I grew accustomed to it. I remember standing for half an hour beside the peasant-farmer of whom I have spoken, before the door of our hut, while the horses were being caught on which we were about to ride. "Leva, leva!" cried the good man; in other words, "Catch him!"—and "Que diablo!" each time a horse got away. Many a Brazilian would stand thus for hours before he himself would lift a hand. One of the most frequent gestures of the Brazilian is to hold out the hand with outstretched fingers. It means: "Patience!"

But after all, in such a great and wealthy country as Brazil there is seldom need for extraordinary haste, and the climate is not favourable to excessive speed or excitement. People always think that the Southern peoples are more vivacious and even more noisy than we are, but this is by no means the case. That great connoisseur of women, Maupassant, chose a thin Englishwoman when he wished to describe a passionate type. The streets of the cities of north-eastern Brazil are very much quieter than ours. There is no pushing and elbowing when the electric trams stop to take on passengers. Those waiting enter the tram as they stand in the queue. There is no crowding at the booking-offices of the railway-stations or the counters of the post-offices. In Recife the clerk of the post-office was acquainted with me, and often entered into conversation with me, but those waiting behind me never grew impatient. And one day, when I was travelling by rail, a lady entered the carriage, accompanied by a little boy who was holding a tin trumpet. The child had no sooner sat down than he put the trumpet to his mouth and blew it, with all the strength of his lungs, for a full hour (I timed him by my watch). No one indignantly turned round to protest; the child might have blown his trumpet for another hour if he had not left the train. In Brazil people are allowed to do as they please; people are not so ready with prohibitions and demands as with us. I feel inclined to advise nervous invalids to make a stay in Pernambuco or Bahia, as a cure.

Of course, the Brazilians have less excitement in their lives than we have; above all, there is no direct taxation! Tariffs and customs duties provide the revenue. The whole life of the country has given the people a repose whose charm is doubled by their amiability. For example, it is not usual to talk loudly in the electric trams; a loud voice at once stamps the speaker as a foreigner. I was always charmed by the repose of the great city of Recife, and especially on travelling homewards, through the quiet night, by the electric tramway, from friends who lived at a distance of about an hour and a half. It is true that I often regretted the absence of music, which one seldom hears among the people; and yet the calm sea along the shore of Olinda, and the wide inlets which traverse Recife, might have been made for boating trips with singing and the music of guitars!

All the time I was in the North-east I never heard an angry word, never witnessed a quarrel. It is true that I was living in the peace of the cloister. And this peace accompanied me even in the more vivacious and Europeanized South. Here I experienced it all the more profoundly when I climbed the steps of my monastery in São Paulo and opened the wrought-iron door, above which stood the solemn word: *Pax*.

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Even in Brazil, of course, life has its dark side. I myself witnessed a military revolution in São Paulo, and I know there is much in the system of government and other institutions which is in need of improvement, and that in Brazil, as in other countries, politics often arouse reprehensible instincts. And this wealthy country still harbours much poverty and wretchedness. Whether one goes north or south on leaving Recife, one passes through wide mangrove-swamps, from which countless islands emerge, which are often so small that they have room only for a negro's cabin, and at high tide the hut alone stands out of the water. Nevertheless, in those latitudes poverty has at least one advantage over her grey Northern sister; no one suffers from cold, and clothes cost but little. The food problem, too, is less serious; fish and meat, and above all fruits, are cheap; and in a high temperature less food is required than in Europe.

Above all, the children of the poor have a better time in Brazil. They are always in the open air, and know nothing of ill-ventilated rooms or cellars. The naked negro urchin has quite a comfortable time. And he is never thrashed! After all, how should he be naughty? He cannot tear and soil his clothes, for he has none, and there is no fragile crockery, no windows to break; fever and other illnesses are his only source of suffering.

The house of a field-worker, negro or otherwise, is quickly built. A wooden framework is erected, and filled in with sun-dried bricks; the roof is thatched with palm-straw (Plate 24). The distribution of the rooms is the same as in the houses of the small towns and villages. The latter are built in terraces, and consist of a ground-floor only. From the street one enters the "Sala d'espera" or reception-room: two windows, right and left—unglazed, of course—and the door in the middle; and the door consists of two leaves, so that the householder or housewife can lean over the half-door and look out into the street. In this room is a table, with a row of chairs on either side, and against the wall is a sofa. This arrangement is made with a view to coffee-drinking when callers drop in. From the reception-room a passage leads to the back of the house. On either side is a bedroom; the bedrooms have no windows, but they are not without light, as the rooms have no ceiling, being covered only by the common roof, from which a certain amount of light is reflected into the rooms in the middle of the house. At the back are the kitchen and the dining-room. The back yard is enclosed by a closet and a room with a shower-bath, and a lean-to for the mule or donkey. When I was in Pernambuco such a house cost 60 milreis (at that time 30s.) monthly, and could be bought for 3,000 milreis (£75).

Living was not dear. I noted these prices in a small country town (Rio Branco): 36 eggs, a shilling; milk, 2½ litres (over half a gallon) for sixpence; five live young pullets, one and sixpence; a kilogram of pork (about two and a quarter pounds), ninepence. In the large towns food was of course dearer, and since I was in Brazil prices have risen. But by planting fruit-trees, and especially banana-plants, anyone can obtain food at little cost and with little labour.

Most of the towns and villages are provided with electric light, and so abundantly that they are blazing with light all night. The people light even the outside of the houses, and the churches are picked out with lights at night. The governmental buildings are kept in good repair, but the railway-stations, as a rule, leave much to be desired. Very different were the delightful railway-stations in Ceylon; these were little gems, with an incomparable display of flowers, for which the Government offers annual prizes. And although in the towns there are often very beautiful parks, the rural roads lack the shade-trees which would complete the charm of the open country. In this particular Ceylon is worth imitating. There the country roads are shaded by a wonderfully beautiful tree, whose branches extend, parasol-wise, far over the causeway, bearing an open foliage of pinnate leaves, so that they give shade, and yet not so much as to prevent the roadway from drying. At night the leaves close, condensing the moisture of the atmosphere, shaking it off when they open in the morning, and thereby equably sprinkling the roadway. Ceylon has expended much labour on the planting of these trees, but now, with their soft shade, through which the sun casts splashes of light on the red surface of the roads, they contribute essentially to the captivating charm of the green island. And the comical thing is that the native home of these Guancos or "rain-trees" is Brazil!

Nature, in giving the tropics the glowing heat of the sun, gave also the means of mitigation. She has produced fig-trees that spread their boughs horizontally, and over such a distance that they are capable of roofing a street, as one may see in Buenos Aires. Certain Leguminosae—the "parasol" acacias, of which there are hundreds of species—are still better adapted for planting in avenues; their boughs slant upwards on either side of the street, forming a sort of Gothic vault; and their foliage is delicate, and not so dense as to cast a deep shade and prevent a road-surface from drying. Europe may well envy the tropics their shade-trees! In Brazil their value is as yet imperfectly realized. One often sees avenues of King-palms, but these give no shade; they have a solemn and dignified appearance, and the rows of their columnar stems have an architectural appearance. The Australian Grevilleas and Eucalyptuses are out of place in Brazil. Not so the Oitys, which are planted in many of the streets of São Paulo.

Brazilian trees should be given the preference; they truly adorn the landscape. The true-born children of the country are always in tune with it. The best way of preserving the beauty of Brazil is to be indefatigable in learning the lessons of Nature. Since the essential character of the tropical forest is variety, so in making new plantations many species of trees should be planted together.

In Brazil there is as yet little understanding of the value of a loving respect for the beauty of the landscape. This struck me especially in Petropolis. The little town is of course delightful, but how much it would gain were the heights that overlook its streets covered not with copsewood or "bush," but with the old, noble virgin forest, made accessible by footpaths! In whatever direction one leaves Petropolis, the many bare heights strike a discord with the rich articulation of the landscape, whose formation is faintly reminiscent of the Black Forest; and even the planning of the streets fails to harmonize with the structure of the landscape. On all sides there are red embankments or cuttings, and even the houses do not always grow harmoniously from the landscape. That acme of tastelessness, the corrugated iron roof, is not seldom to be seen in the loveliest surroundings, and even in the gardens!

Young copsewood, in Brazil, is often predominantly grey in colour, and the uniform height of its foliage seems doubly unnatural in a country of virgin forests. In Europe even the copses delight us with their tender green; but in Brazil the vigorous, glossy, deep green of the tropical forest appears only when the trees have grown to a considerable height; and one sees it in its perfection only when trees of many species are growing together. Great bamboo thickets are always pleasing as roadside hedges.

Surfaces of broken turf, extensive quarries, and gaping wounds in the red earth give the landscape a mean and infertile aspect; all the more so as no luscious foliage fills the intervals with its verdant veil. In Brazil, even more than in Ceylon, I always found that the discords which man introduces into the landscape are sensibly greater than in Europe. Land which is devoted to a single crop, and cultivated solely with an eye to profit, or land which has already been abandoned and is lying waste, may, if for hours it lies on either side of the line, make a railway-journey a positively painful experience. One breathes more freely when the train once more passes a section of untouched forest. Cool, refreshing rain after long drought is not more welcome.

For these reasons it is most important that the Brazilian Government should create a special department for the preservation of natural beauty. This should advise not only the rural authorities, but also the cities. In some of the residential quarters the architects have been guilty of positive orgies of building. Here stands a house with Moorish arches and a turret, as though the owner had acquired a harem; beside it rises a Florentine palace, then a Roman dwelling, and an Old German timber-framed house. These harmonize neither with one another nor with the capital of Brazil. What a different aspect would Rio have worn had she adapted her architecture to the incomparable landscape! The best foundation for a harmonious renaissance of the cities of Brazil is the simple, fine old Portuguese Colonial style (Plate 32).

How often Brazilians have said to me, full of pride: "Isn't São Paulo quite a European city?" I have always replied that it was not desirable that Brazil should be an echo of Europe, but that one would, on the contrary, have reason for pride if a Brazilian city were genuinely Brazilian in appearance, and as little European as possible. For Brazil has a personality of its own, and the value of this personality is such that it ought to be stamped upon the whole country.

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If we compare Brazil with Germany, we note the following points of difference:

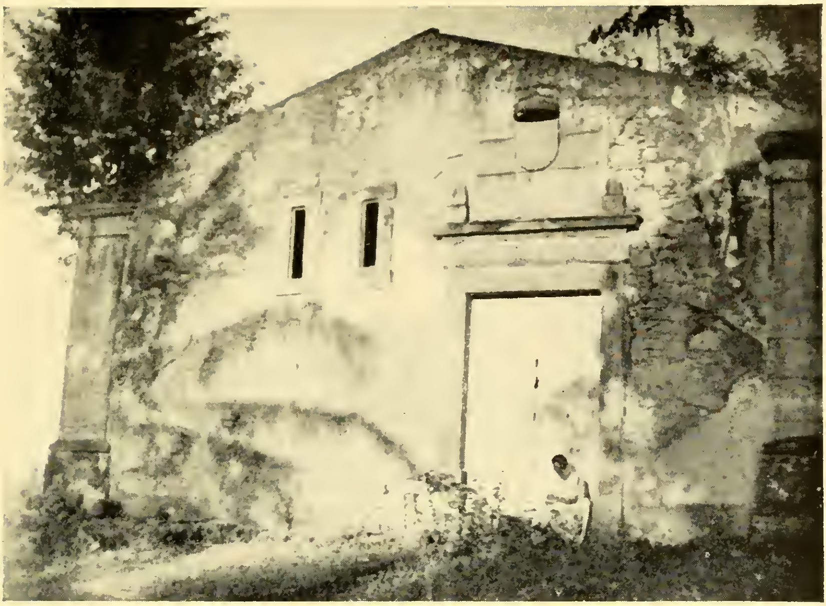
The German people has been settled for thousands of years on its own soil. From the German forest it emerged into the light of history; in the forest its personality and its character were formed. The forests and rivers, the mountains and valleys of the Fatherland were the environment and formed the actors of the German sagas and folk-tales; in the folk-songs of our people we hear the rustle of our trees and the song of our birds; and even our German folklore and art and architecture evolved in contact with Nature, and the more homegrown they were, the more harmonious were the forms which they assumed. Thus, in Germany Nature and the people have always been united; their relation has been like that of mother and child, and to this relation we owe the best that is in us, the best that we have achieved.

There have indeed been seasons of estrangement from Nature; we are passing through such a period even now; and there have always been times when German art was at its feeblest. But the whole inheritance of native art and culture is still ours, and in all parts of Germany, despite much destruction, Nature, the eternally youthful, still survives, with her rustling forests, her flower-bedecked meadows, and the song of her birds. And there have been and will always be those among us to whom the emergence of all that is truly German from the German land itself was and will always be a thing to remember, a thing to hold fast; those who will hand on this inheritance from the days of old to the generations yet to come.

It is otherwise in Brazil. Modern Brazil is not evolving in a living relation to the Brazil of antiquity. There is a great rift in the history of the country: the year 1500. The old immemorial evolution was suddenly cut short; the new is the child of an alien hemisphere, which has transplanted its achievements in a foreign continent without seeking to achieve an organic relation to the country. Thus, the architecture introduced was Baroque: a style born of the European spirit, which had neither time nor opportunity to make itself at home in a land of such alien character.

More: the new arrivals, the white conquerors of America, had no intention of creating a new home; for them the newly-discovered country was a land of colonies, which they sought to exploit with all possible speed, in order to return home with their gains, and consume them in Europe. And even to-day this point of view is by no means extinct in South America. Even to-day there are many who regard the country merely as an object of exploitation, and who seek their pleasures in the great cities of Europe, or in those South American cities which are striving to form themselves on the European pattern.

A third injury is inflicted by the accelerated tempo of the century. The new-comer feels that he has no time to naturalize himself in



THE OLDEST HOUSE IN BRAZIL, PARAHYBA

A HOUSE IN RECIFE

the country, to become a living part of it; and many things which were perhaps worthy to strike root in the soil are swept away by their successors. The growth of the cities is proceeding at such a pace that men are forced to build where and how the opportunity offers. In São Paulo a house is finished every hour. Thus, even in such a vast country as Brazil, too hasty settlement and too rapid an increase of the population are deepening the gulf between Nature and human activities.

Once—namely, before the close of the fifteenth century—this was otherwise. Then America had her own people, which, having sprung from her soil, had evolved, and developed its culture, in intimate relation with its natural environment. That the Indians were capable of building up a high civilization they showed in Peru and in Mexico. In the La Plata Museum (Plate 26) I saw a collection of vases found in the province of Catamarca, in Northern Argentina, whose refinement of form and nobility of design were worthy of all admiration. The more we learn of the ancient Indian civilization, the more intolerable is it to remember that the crushing of this civilization by the conquerors has deprived us of a promising and irretrievable bough of the tree of human evolution, and robbed us too of the harmonious evolution of the continent from the soil of its own past.

From this point of view I am forced to regret that Columbus ever discovered America. If only the Europeans had arrived a few centuries later they would have been readier to receive the treasures offered them, and the Indians might have been able to develop their States and their defences to such a point as to retain their country for themselves. America would then indeed have been a New World for us, an individual work of art, and would have exerted a fascination equal to that of India, which, as I myself have often felt, does not excel Brazil in natural beauty, but only in the fact that the works of man have in the course of the centuries harmoniously taken their proper place in the landscape, down to the cultivated fields, the cities, and the people themselves, with their clothes and their customs. All these are Indian, and so the impression produced by the whole is individual and consistent.

It will be objected that the civilization of the Brazilian natives was by no means equal to that of Peru and Mexico. But who can say that a people has not the power of evolving? As a forest folk, the Indians of Brazil had as little reason as the Germans to erect buildings of stone. As regards their character and their abilities, such an expert as Koch Grünberg gives a favourable enough report; and of the Guarani Indians both history and literature record much that is commendable. Of their love and care of animals I spoke in my eleventh chapter; as regards their knowledge of Nature, H. von Ihering writes: "Just as the North American Indian attracts our attention by the skill in tracking and the sensitive powers of observation which guide him when on the war-path, or hunting, so the Tupis and Guaranis are deserving of our interest, and even our admiration, by reason of their thorough knowledge of the flora and fauna of the country."

Even to-day every visitor to Brazil will be forced to acknowledge the Indians' subtle understanding of the Brazilian flora and fauna if he will consider the significance of the names which the majority of animals, plants, rivers and mountains bear as their Indian inheritance. Like the faint echo of harpstrings these names tell us of the lovable people who were once the rulers of the beautiful land, and at the same time its children, born of its womb.

. . . . .

More than a hundred years ago Brazil underwent yet another transformation, and this was like the rising of a sun, that throws its beams far into the future. Brazil is now no colony, but an independent State. The Brazilian people have taken their destiny into their own hands; everywhere one meets with signs of fresh developments; from year to year the prospects of agriculture, industry, trade, communications, science and art become more full of promise; in short, all is prospering. The Brazilian loves the country; many of the townspeople are endeavouring to settle in the rural districts; and I met landowners who assured me that they were preparing to make their estates their home, and to regard them not only as a business venture, but as a recreation. Such landowners are the best of all citizens.

No one who visits Brazil will have doubts as to the future of the State. Brazil is one of the four empires of the earth which can produce within their own limits all that they require. I took some pains to convince myself that the people were everywhere doing their utmost to make themselves independent of the outer world; and I must say that my experimental purchases of Brazilian body-linen, clothing, and "National silks," were entirely satisfactory. In view of this progressive transformation Europe should avoid still further increasing her industries. The world's face is changing, and the sooner people adapt themselves to this change the better.

But as history teaches us, the increasing wealth of a people by no means safeguards its future. More important is the physical and spiritual power that such a people draws from its country. Such a power is a living force, and like all living things, it evolves, organically, from its environment. Brazil must create her own, home-grown civilization, and in order to do this she must re-knit the threads which were broken at the time of the conquest, and bind the new Brazil with living bonds to the old Brazil of thousands of years ago.

This is by no means a hopeless task; on the contrary, its solution is already silently taking shape. In Rio, August Herborth has endeavoured to awaken interest in the ancient Indian art by his *Deutsch-Brazilianischen Illustrierten* (Hamburg). He believes that this art, which was born of an incredibly rich imagination in the invention of forms and motives—he has already classified 700 different elements—may now be destined to initiate a new period of national Brazilian art. The virgin forest was the cradle of this art; and thus we see that many departments of human activity, all rich in promise for the future, are united at their source—which is Nature. In this connection we find that the Indian names of natural objects form a connecting-link with the days of old, and so do many of the customs which have come down to the Brazilian people of to-day, and so does the blood which the present owners of the country have inherited from its ancient lords. The Secretary of State of Parahyba told me that the blood of all three races flowed in his veins; and he added that it should interest me, as a naturalist, to know that Brazil's solution of her racial problem differs from that adopted by other countries. In North America the gulf between black and white is deliberately kept open, and since the negroes are multiplying rapidly, there might in time be a fight for supremacy. In Brazil the black race would be gradually and peaceably absorbed, since it would receive no fresh recruits. As a matter of fact, I was able to observe all the stages of this process. The last vestiges of negro forefathers, as I was able to observe for myself, are often the slightly protruding eyes and the frequent, open-throated laugh. Even among the half-castes, the mulattoes, and still more frequently among the "Morenas," who have one-fourth part, or even less, of black blood in their veins, there are individuals of great physical beauty, especially of the female sex, whose large black eyes and absolutely flawless and beautifully coloured brown skin make a profound impression on the beholder. And whatever one's attitude may be to the racial problem, since Brazil is for the most part a tropical country, and since of all races the black is best adapted to life in the equatorial zone, who knows but what the black element is essential to the future of the Brazilian people?

But far more abundantly than negro blood the blood of the Indians flows through the veins of the Brazilian people; in some regions indeed the latter seems to be reverting to the Indian type. For this the climate may be in part responsible. Indian forefathers are by no means regarded with distaste; indeed, as in Spanish America, many old families point with pride to the Indian chieftains in their family tree.

As José de Alencar, in his admirable works, gave new life to the old Brazil and its Indian inhabitants, so, it is to be hoped, the pithy Indian tales of animals may become better known to the children of to-day. Above all, may the love of Nature of these old rulers of the land be awakened, with equal vitality, in the hearts of the present inhabitants! Then Brazil will cherish its own beauty; for the people that has learned to find happiness and wisdom in Nature will not fail to protect her. The best security for the future is a genuine love of one's homeland. Lastly, commerce with Nature can but ennoble a people, for the heart that beats in sympathy with each lovable living creature increases its power of loving, and the harmony of Nature clears the vision for the eternal values.

With such wishes for the future of Brazil I will close this book. These wishes I expressed also in the lectures which I ventured to give in Brazil as I improved my knowledge of the Portuguese language. And by such hints I believe I am repaying my amiable hosts more effectively than by the fact that I helped them in their campaign against a few of their agricultural pests.

INDEX

Abacate, Persea gratissima (Lauraceae), 139
Abacaxi or Pineapple, Ananas sativus (Bromeliaceae), 107, 140
Abrolhos, the, 31
Acacias, 366
Acará or Chanchito, Cichlasoma facetum, 274
Actaeon, Megasoma actaeon, 279
Aden, 48
"Aeroplane butterflies," 217–20
Agave. The native Agave, which is cultivated in plantations, is Fourcroya foetida. The leaves, after crushing, maceration, washing and drying, yield the aloe fibres which are sometimes known to commerce as "Mauritius hemp," as the Agave is extensively cultivated in Mauritius. Fibres are obtained also from the great Mexican Agave, the Sisal Agave, and the Maguey Agave (Agave americana). These fibres are used for making ships' cables, hammocks, sacking and other textile fabrics, and the useful varieties of Agave are cultivated in all parts of the tropics. The Agave Americana is widely distributed as an ornamental plant, and since it is able to endure a certain amount of frost, it has become so common in Italy that on the Riviera the green tuft of leaves, from the midst of which the tall inflorescence rises into the air, has become a characteristic plant. 116
Ageronia, *see* Rattle-Butterfly.
Agouti, *see* Cutia.
Agrias, 217
Alarm frog, Hyla crepitans, 116
Albatross, 49–50
Alligator, *see* Caiman.
Alma do gato, *see* Anum.
Aloe, *see* Agave.
Alto da Serra, 91, 98, 106, 108, 199
Amazon Parrot. The yellow-faced species is Amazona ochrocephala; the blue-faced, Amazona aestiva. The all-green bird with a fine red on the back between the wings is Amazona festiva. 125
Ameixas, 136
Anaconda, *see* Sucury.
Ananas, *see* Abacaxi.
Anartia, 217
Andaassú, Joannesia princeps (Euphorbiaceae), 68
Androgynous flowers, 231
Angelim. There is sweet Angelim, Angelim doce (Andira fraxinifolia), and bitter Angelim, Angelim amargoso (Andira anthelmintica). The wood of the latter is so bitter that if one saws it the bitter taste lingers in one's mouth for days (Leguminosae). 77
Angico, Piptadenia colubrina, and P. rigida, 68
Animal Geography, R. Hesse, *Tiergeographie auf ökologischer Grundlage*, Jena, 1924, Z. Dahl, *Grundlagen einer ökologischen Tiergeographie*, Jena, 1921. Th. Arldt, *Die Entwicklung der Kontinente und ihrer Lebewelt*, Leipzig, 1907. R. v. Ihering, *Archhelenis und Archinotis*, Leipzig, 1907–13. 138–61
Anona. Several species: Pinho (Anona squamosa), Ox-heart, Coraçõa de boi or Fructa de conde (Anona reticulata), Cherimolia (Anona cherimolia), also

known as Queen-heart. Lastly, Guanabano or Sapadilla (Anona muricata). Anonaceas, 139

Ants. The most recent authority is Professor A. Forel, *Le monde social des fourmis*, Geneva, 1921–3. *See also* K. Escherich, *Die Ameise*, Brunswick, 1917; M. Wheeler, *Ants*, New York, 1913; and Wasmann, *Das Gesellschaftsleben der Ameisen*, Münich, 1915. For Brazil, Th. Borgmeier, *Estados myrmecologicos*. S. Paulo, 1922. 195–6, 303–24

Ant-acacia, Acacia sphaerocephala, 319–20

Ant-birds, Formicariidae. Very numerous and useful birds, like the dark blue Chóca (Thamnophilus coerulescens), Papaformigas (Formicovora rufa), Fire-eye, Papataoca (Pyriglena atra and leucoptera), Galinha do matto (Formicarius ruficeps). 196, 314

Anteaters. The Great Anteater, Tamanduá-bandeira (Myrmecophaga tridactyla), the Lesser Anteater, Tamandua (Tamanduá tridactyla), and the Small Anteater, a climbing animal with prehensile tail, Tamanduá-i (Cyclopes didactylus), 169–70, 182

Ant-gardens, of Azteca, Ulei olitrix, Traili, Camponotus femoratus, Crematogaster limatus. The plants are mostly Bromeliaceae and Gesneriaceae.—*See* Ulele, *Die Ameisen-gärten im Amazonasgebiet. Englers bot. Jahrbuch*, 1902. 318–19

Ant-head Flies, *see* Flies, 316

Ant-Imbauba, 319

Antler Fern, Platycerium. Some of the Polypodia too develop special leaves and form "flowerpots." 109

Ant-purses in the Melastomaceae, Marita, Myrmedone, Tocaca, 319–20

Ant-Wasps, Mutillae. In São Paulo, Mutilla cephalotes, reminiscent of the Sauva ants, 281–2

Anum. The black bird is Crotophaga ani; the spotted bird is Guira guira. The Almo do gato is Piaya cayana. These cuckoos do not lay their eggs in other birds' nests; they incubate them, sometimes in communal or social nests, 154, 258

Aphides, 282

Apocephalus, 316

Araça do Brejo, *see* Posoqueria.

Araceae, Caladium bicolor, marmoratum and pictoratum, 102

Arapaçu, Tree-creeper, Dendrocolaptes picumnus, do bico curvo (with curved bill), Xiphorhynchus falcularius, 161, 175

Arapaima or Pirarucu (Arapaima gigas), 176

Araponga, also Ferreiro, Procnias (Chasmorhynchus) nudicollis, snow-white with green throat, more common in the South; Ch. variegatus with brown wings in the North, 250

Araucaria, Pinheiro, Araucaria brasiliana. In the cones are seeds as large as almonds, which when cooked taste like chestnuts. Swine are fattened in the araucaria woods. The two other Conifers of Southern Brazil are Podocarpus Sellowii and P. Lamperti, whose "needles" are so broad that they may be regarded as leaves. The needles of Sellowii are reminiscent of willow-leaves, 85, 134

Arirabá, Centrolobium tomentosum, 68

Aristolochia gigantea. The bloom of A. ornithocephala is like a bird's head. The root-stock of A. anguicida, "Snake-killer," is given as an antidote to snake-bite. A. brasiliensis is called Milhome, and A. cymbifera Jarrinha, 236, 239

Armadillos, Tatú verdadeiro (Tatus novemcinctus), Tatú do sul (Dasypus sexcinctus), Tatú bóla (Tolipeutes tricinctus), and the rare, large Tatú canastra (Priodontes giganteus), 169–70, 182

Artichoke, Topinambur (Helianthus tuberosus). From North America (Compositae), 144
Arums (Araceae), 82, 239
Asparagus Beetle, Crioceris asparagi, in Java C. subpolita. Hesse's calculations concerning, 163
Assude, storage-tank, 129
Aztec ants, 318–20
Azure bindweed, Thunbergia azurea grandiflora (Acanthaceae). Also Ipomoea caerica and I. purpurea (red). (Convolvulaceae), 97, 98

Bactris. The fruits of these palms are edible. The Marajá is Bactris Marajá. The Pupunha-palm (B. or Guilielma speciosa) is cultivated by the Amazon Indians, its fruits being roasted like our chestnuts, 84
Bacuráu, *see* Nightjars.
Bagre = Catfish. The Incubating Catfish is Arius commersoni.
Bahia, 26, 30, 31, 47
Bahia morpho, *see* Morpho bahiana.
Baixada, 71
Ball-nested Wasps, Polybia scutellaris and micans. The wasp with the bag-shaped nest is Polybia rejecta, 293–4
Balsam plum, *see* Cajá.
Bamboo Palm, Palmeira bambú, Areca lutescens. The Raffia Palm, which occurs in Africa and about the mouths of the Amazon, is likewise known as a Bamboo Palm.—These palms have only a short stem, or even none, but the leaves grow to a length of 60 feet and more; they are the longest leaves known. 135
Bamboos, 82
Banana (Musa sapientum and paradisiaca, Musaceae), probably from India. The Dwarf Bananas, about six feet in height (M. Cavendishi) come from South China. 121, 141–2
Banana do brejo, *see* Monstera.
Banyan, 78–9
Barata, cockroach, Periplaneta americana, 28
Barata do mar, Rock- or Water-louse, Ligia, related to the Wood-louse; a crustacean, 47
Barba do velho, *see* Greybeard.
Barbeiro, *see* Wedgenosed Bug.
Bark-bug, Phloea corticaria, 224, 287
Barriguda, Chorisia ventricosa. Another species is known as Paina de seda, the seeds being embedded in a silky cotton. These trees belong to the Silk-Cotton trees (Bombaceae), 122
Batata doce or Sweet Potato, Ipomoea batatas (Convolvulaceae), from Central America. The Batata has to some extent replaced the culture of a similar tuberous plant, which is related to the Irises, the Yam (Dioscorea triloba, bulbifera and others; Dioscoreaceae). The Batata ingleza is our Potato, Solanum tuberosum. 143
Bat-fish (Malthidae), 47
Batrachians, 17
Bats, bloodsucking, *see* Vampires. The bats which fly over the water and catch fish and shrimps belong to the genus Noctilio (leporinus). 59, 354–5
"Batumen," 299
Bauhinia (Leguminosae), 81, 95–6

Bean, Black, Feijão preto, Phaseolus derasus (Leguminosae), from America, 142

Beard Aztec (ant), 320

Bees, Brazilian, Melipona. Names of some of the Brazilian bees are: the "Eye-lickers," Lambe olhos, M. Duckei and others; the Lemon Bee, Limão, Iraxim, M. limão; the "Fire-biter," in Brazilian Cagofogo, a bee with a painful bite, M. tataira; Jaty, M. jaty; Borá, M. clavipes; Jatahy mosquito, M. mosquito; Sloth-bee, Preguiça, M. Butteli; Mandaguary, M. coerulea; Cupira, in termitaries, M. cupira; the Dog-bee, Cachorro, M. argentata and fulviventris; Irapuan, M. ruficrus; Irussú mineiro, M. subterranea; Urussú, M. scutellaris; Mandary, M. interrupta; Mandassaia, M. anthidioides.—*See* J. v. Ihering, *Biologie der stachellosen Bienen Brasiliens. Zoöl. Jahrbücher, Abteilung Systematik*, 1903; A. Ducke, *Die Stachellosen Bienen Braziliens*, ibid., 1925, 126, 289–90, 294–302

Bee-ants, Camponotus abdominalis, 301

Beetles, 176, 227

Begonia, 98

Bemtevi, Pitangus sulphuratus Maximiliani, 59, 161, 195, 196, 250, 310

Benedictine monastery, Olinda, 21, 27–8, 356

Benjamin fig, 79

Bicho berne, Dermatobia hominis, 350

Bicho de pé, *see* Sand-flea.

Bell-bird = Araponga.

Bignoniaceae, a family consisting chiefly of tropical plants. In Europe the Catalpa (C. bignonioides), with its huge heart-shaped leaves and beautiful rosy-white flowers, has been introduced from the Southern regions of North America; and so has the Trumpet-flower (Tecoma radicans), a creeper which, like ivy, climbs by means of rootlets, and bears handsome red flowers. In Brazil the family is represented by the Jacarandá, the Pau d'arco or Bow-wood tree, and the Ipê, 70

Bird's-nest Fern, Asplenium nidus, forms a sort of crater for the collection of humus with its close-fitting fronds, 109

Bird-spider, Carangue jeira. The black species is Grammostola actaeon; in the forest I saw the brown Lasiodora, hurrying over the ground like a little hairy bear. 284–5

Bishop's Heliconia (Heliconia episcopalis), one of the Musaceae. The handsome flowers open in succession, from below upwards, 74

Bladder-kelp or bladder-wrack, Fucus, 55

Bladder wort, Utricularia nelumbifolia (Lentibulariaceae), 108

Blue Raven, Cancão or Urraca, Cyanocorax cyanopogon, 125, 196

Boa constrictor, *see* Giboya.

Bombycidae, 226, 279

"Bond," the, 26

Borboleta, Hedychium coronarium. Borb. amarella, Hed. flavescens, from Southern Asia, has run wild in Brazil (Zingiberaceae), 71

Boto, 49

Bo-tree, Ficus religiosus, 81

Bougainvillea, Primavera, 238

Bow-wood tree, *see* Pau d'arco, 70

Brassolis astyra, a Butterfly, related to the Morphidae, 154, 191, 193

Braúna, Melanoxylon brauna (Leguminosae), 77

Brazilian broom, Bacharis genistaloides, 347

Brazil-nut tree, Bertholletia excelsa (Lecythidaceae), 77

Brazil-wood, Pau brasil, Caesalpinia echinata, 76

Breadfruit tree, Arctocarpus incisa, from upper India and the East Indies, and naturalized by the natives of Polynesia, where it is possible to live almost entirely on this fruit. 80, 143
Brehm's *Tierleben*, 4th ed., Leipzig, 1918
Brejo, 115
Brenthidae, Weevils, 227
Bromelias. Aregalia princeps; the inner side of the leaves is red. In A. nidularium the rosette is marked with red. The Coral Bromelia is Aechmea fulgens discolor. Vriesea psittacina and V. carnata have red flowers. The Rock Bromelia, Gravatá de pedra, is Aechmea nudicaules. 102, 106–110, 121, 190, 239
Bronze Bees. The genus Euglossa, with a suctorial proboscis whose length exceeds that of the body, which has a splendid metallic lustre, usually green, 207
Bronze Wasps, Chalcidinae. In Southern Brazil and Paraguay, Phlebopenes splendidulus, with blue head and thorax, copper-red abdomen, with blackish-green tip; in São Paulo, Smicra bergi, 207, 283
Brood, care of and forethought for, 266 *et seq.*
Bugs, Persevejos (Hemiptera), 207, 224–5, 351
Bumble-bees, Mamangaba, Bombus cayennensis and carbonarius; the strong-smelling species B. violaceus, 295
"Bundle-nester," *see* Curutiá and Turucuhé.
Burity, Mauritia vinifera (Palmae), is used for making wine. The fruit has a handsomely ridged rind, 84
Burnet-moths, Zygaenidae and Syntomidae. The moth mimicking a wasp is Trichura caudata, 221–2
"Bush cables," 94
Bush-knife, 97
Butantan, 345–8

Cabochinho, Sporophila nigroaurantia, 257
Caboclo, 119
Cabo Frio, 33
Cacao, Theobroma cacao (Sterculiaceae), 80, 146
Cacti; Chandelier cactus or Facheiro, Cereus candelabriformis; Chique-chique, Cereus setosus; Fig Cactus, Prickly pear, Opunta brasiliensis, O. monocantha, and other species; Melon Cactus, or Coroa de frade, Melocactus communis. 105–6, 120–1, 126, 241
Cagasebito, Polyoptila livida, a pretty black and white bird, 153
Cajá. Cajá manga, Spondias dulcis, from Polynesia; Cajá mirim, Spondias lutea, a native of America and West Africa (Anacardiaceae), 137–8
Cajú, *see* Cashew.
Caiman. America is the land of Alligators and Caimans; Crocodiles are found only in Central America and the northern part of South America, particularly the Orinoco, where the Crocodilus americanus is found. Humboldt measured a specimen which was over 16 feet in length, and Bonpland one nearly 23 feet in length. In the south-east of the United States the Mississippi Alligator has its home. It is bred in Florida for the sake of its skin. Of the South American Caimans the Black Caiman (Caiman niger), the Spectacled Caiman (Caiman sclerops) and the common Jacaré (Caiman latirostris) are the most frequently seen. 59–61, 190
Caladium, 82
Caligo, 183, 191

Camarão, prawns, which swim or bury themselves in the sand; they are larger than the European prawns (Palaemon potitinga, Macrobrachium and Penaeus brasiliensis). In fresh water, Palaemon jamaicensis. Before the discovery of Brazil whole tribes of Indians lived on prawns, which they called "Poty." 47
Cambará, Lantana mista (Verbenaceae), 155–6
Campeche, Haemotoxylon campecheanum (Leguminosae), 77
Campina grande, 118–20
Campos, 114
Canary, Canario do Ceará, Sicilis flaveola. Fringillidae, 189, 248
Candiru, 176
Canella commum, Ocotea variabilis; Can. oarda Nectandra puberula (Lauraceae), 77
Cangamba, *see* Skunk.
Caninanha, Phrynonax sulphureus, 343–4
Canna or Flowering Rush; the yellow Canna is C. lutea, the orange-red, C. indica, gigantea and speciosa. Cannaceae, related to the Bananas (Musaceae), not to the Liliaceae, 238
Caoutchouc tree, 68
Cape pigeon, Daption capensis, 50
Capim, *see* Grass.
Capoeira, 115
Capricornidae, 221, 227
Capucin monkeys: Cebus capucinus from Guayana, Cebus apella, Cebus fatuellus, Cebus cirrifer, and Cebus azarae from Brazil, where they are known as Macaco Prégo, Mico de Tapete, and Caiarára, 174, 267
Capyvara, Spanish Carpincho, Hydrochoerus capybara; fortunately for the animal, the flesh is not good eating; but the skin is used by saddlers. 58, 172, 201
Caracará or Carancho, Polyborus tharus, 127
Carangeijo = Crab.
Carapicho, Cenchrus echinatus, tribuloides and others (Gramineae), 124.
Caravella (Physalia arethusa), one of the Hydromedusae, really belongs to the social polyps (Siphonophores). All the polyps of the colony are connected by a system of ducts. The symbiotic fish is Nomeus gronovii, 43–5
Cardboard Ants, *see* Pasteboard Ants.
Cariri, 120
Carnauba or Carnaubeira. Copernicia cerifera (Palmae), 121–2
Carnivora, 127–8, 177
Carpenter-Bee, *see* Wood Bee.
Carrapatos, *see* Ticks.
Carrixa or Cambaxirra, Troglodytes musculus, 22, 28, 255
Caruarú, 53, 117–18
Cascavel, *see* Snakes, Venomous.
Cashew, 40–1, 82–3
Cassava, 143
Cassia obovata, also introduced into India; Cassia grandis, Mari-Mari (Leguminosae), 98, 239
Cassidinae, 203
Castor-oil plant, Ricinus, Ricinus communis (Euphorbiaceae), 156
Catfish, *see* Bagre. The Surubi pintado is a Catfish over 6 feet in length; another Catfish is the Jahú (Paulicea lukeni); the Armoured Catfish is Callichthys pictus, and the brood-rearing Catfish is Arius commersoni, 275–6
Cat-frog, Phyllomedusa Iheringi and other species, 272

Catingas, 114
Catingeiro, or Capim gordura, or Capim mellado, Melinis minutiflora, of African origin, cultivated as forage, and also common in the wild state (Gramineae), 133
Cat's-claws, Bignonia unguiscati and B. argyro violacea (Bignoniaceae), 93–4
Cauã, Urubutinga urubutinga, a black bird of prey with white rump. 216
Cavallo do cãe, *see* Hornets.
Caviidae, to which the Cutias and Capyvaras belong, 172
Cavy, wild, Preyá Cavea aperea; the Moco (Cerodon spixi) is rather larger; in the rocks, Cerodon rupestris. 127
Caxas, 150
Ceara = Caoutchouc; *see* Maniçoba.
Cedro, Cedrella odorata (Meliaceae), 77
Centropogon surinamense (Campanulaceae), 239
Cereals: Wheat, Trigo, Triticum sativum; Oats, Aveia, Avena sativa; Barley, Cevada, Hordeum sativum, 145
Cereus, 241
Ceylon, 25, 26, 38, 60, 79, 101, 114, 121, 131, 155–6, 250, 253, 327, 330, 346, 365
Chacaras, 145
Chagas, *see* Wedge-nosed Bug.
Chameleão, 59
Characinidae, 175–6
Checheou. A large, handsome bird, black and yellow. Cassicus persicus, or C. cela. In Southern Brazil there is a bird about half as large, Cassicus chrysopterus, known as Melro. 59, 216, 256
Cherimolia, *see* Cacti.
Chicken-eating snake, Spilotes pullatus, 343
Chinchilla, Chinchilla brevicaudata and C. laniger, 173
Chique chique, *see* Cacti.
Chrysomelidae, 203
Cicada, Cigarra, in Brazil the genera Tibicina and Zamara predominate, 86–7, 183, 225, 251–2
Cipo tapé, 98
Cipós = Lianas, 88, 97
Clamatores, 253
Climate, 64–5
Climbing Bamboos. Various species: Athrocstachys capitata, Merostachys Kunthiana, Guadua, and Arthrostylidium. *See* Schenck on Lianas. 91
Climbing Ferns. The Lygodiae are principally confined to the Old World, but they occur also in America, and even overflow the tropical zone. The Japanese Climbing Fern is cultivated as an indoor plant. In the Lyg. articulatum of New Zealand the climbing stem reaches a length of 100 feet. 91
Climbing Grass, *see* Scleria.
Climbing Palms, 91
Clover, dependent on bees, 233
Clubfoot, Oedipoda, Locust, 261
Coatá, 175
Coati, 178–9
Cobra, *see* Snakes; Cobra cipó, *see* Liana-snake, 346
Cobra das duas cabeças, *see* Two-headed Snake.
Cockchafer; the golden species is Plusiotes; a nocturnal insect, and rare, 207
Cockroach, Green, Panchlora viridis, 287

Coconut-palm, Cocos nucifera, 38–40

Cocoon, 279

Coffee, Cafe, Coffea arabica, liberica and others (Rubiaceae), 147–8

Coffee-beetle, Stephanoderes coffeae (Bruchidae), 149

Coffee-fungus, Ceylon coffee-leaf disease; Hemileia vastatrix, 148

Coffee-scale, Cerococcus parahybensis, 149

Coffer-fish, 46

Colaenis, 217

Commelina deficiens, belong to the Commelinaceae, to which the "Jew's beard," Tradescantia, whose leaves resemble those of Commelina, likewise belongs, 240

Condor, 54

Conifers. In Southern Brazil there are three conifers, Araucaria brasiliensis and two Podocarpi, P. Lamberti and P. Sellowii, in which the "needles" are flat, with midribs, and in the latter tree so large that they remind one of willow-leaves. 85

Copra, 40

Coracão de boi, *see* Anona.

Coral Snake, Cobra corral. The venomous forms are Elaps corallinus and E. frontalis; the non-venomous forms are Erythrolamprus Aesculapii and Oxyrhopus trigeminus, 342

Corcovado, 36, 134

Coroa de frade, *see* Cactus.

Cotinga or Anambé, Cotinga cincta, a glorious blue with violet throat and violet stripes over the belly, 175

Cotton, Algodão, Gossypium (Malvaceae). In Brazil, Gossypium barbadense, hirsutum, Brasiliensis and their hybrids. No less than 40 species are distinguished, of which 7 are wild in Australia and the Polynesian Archipelago; the others are native to Upper India, California, Mexico, Yucatan and Brazil. The West-Indian cotton is G. barbadense, from which the perennial variety, "Moco," is derived. The crude cotton, G. hirsutum, also known as "Upland Cotton," comes from Mexico; it is cultivated chiefly in the Southern United States. It is an annual; it is cut down at harvest-time and replanted each year. Two-thirds of the world's cotton-crop is yielded by this plant. Cotton is recorded as having been first cultivated in India about 800 B.C.; in the New World the culture of the plant must have evolved independently, as it was already cultivated long before the discovery of America. 151–4

Cotton-bug, Oxycarenus hyalinipennis, 191

Crabs. The crabs occurring in the mangrove-swamps belong to the genus Uca (leptodactyla, vocator). To another genus belongs Ucides cordatus, the food of the working classes in Rio. When the English were once about to land on Hispaniola in the West Indies, the land-crabs coming down to the sea to lay their eggs made such a clatter with their claws that the English commanders believed that Spanish cavalry were approaching, and drew off again. It is said that a feast of crabs is still held annually in this island. 54–7

Crayfish, Lagosta. Palinuris argus, laevicauda, guttatus, 47

Crocodile, 60–1

Croton (Euphorbiaceae), 120

Crustacea, *see* Crabs, Prawns, Lobsters, Camarão.

Cruz, Oswaldo, 349

Cuckoo-bees, nomads, 295

Cuckoos, *see* Anum.
Cucujo, *see* Fireflies, Luminous Beetles.
Cumbarú, Dipteryx odorata (Leguminosae), 77
Cupim, *see* Termites.
Cupim ants, Leptogenys, 321
Curutiá, Synallaxis cinnamomea (Pl. 28, 19), known also as Cazaca di couro, or Sacy-Pereré, 86, 161, 251
Cutiá or Agouti, Dasyprocta aguti and azarae, 136, 173
Cuyabana, Pronolepis fulva. *See* report by C. Morevia, *Entomologia Agricola Brasileira*, Rio de Janeiro, 1921, 321

Danaidae, 163, 164, 220
Death's head monkey, Saimiri sciureus, 174
Decker, Siegfried. *Aus São Paulos Gartenwelt. Gartenschönheit*, Berlin, March 1923. 98
Deer. The largest species of South America deer is the Swamp-deer, the "Cervo," equal in size to the European Red Deer, but with forked antlers, each point or limb being further ramified (Odocoilus dichotomus). On the open grassy plains lives the Pampas Deer or Veado branco (Odocoilus bezoarcticus), the size of a Roebuck, with low, complex antlers. The Guemals (Hippocamelas) are found more in the Andes and Patagonia; but the Brockets are genuinely Brazilian. With their unbranched spikes of antlers and their very small, slender bodies they remind one of antelopes; but the Brazilians call the Brocket a Roebuck, Veado. There is a grey Brocket (Mazama nemorivaga) on the plains and a red Brocket (Mazama rufa) in the bush and forest. 177, 267
Dendrobium (Orchids), 105
Didonis, 217
Dinoponera (ant), 323
Dione moneta, 207
Dirt-bug, Opisicoctus (Reduvius) personatus, 351
Dismorphia, 219
Diver, Podylimnus podiceps. The beak has two cross-bands, and a black streak runs to the eye, so that the face has a mask-like aspect. 119
Dolphins. There is a special dolphin which frequents the brackish water of bays and estuaries (Sotalia brasiliensis). In the Amazon and other rivers of South America is a fresh-water Dolphin with a beak-like snout. This species is known as Inia or Bufeo (Inia geoffroyensis), 49
Dragonflies, with red wings, Heterina pudica, with golden-yellow wings, black at the tips, Thore boliviana, 207, 261, 280
Dragon-tree, Dracaena marginata and Cordyline terminalis, with handsomely marked leaves. Humboldt's description of the Dragon-tree of Teneriffe is well known. The age of this tree was formerly estimated to be 5,000 to 6,000 years. 134
Driver Ants, *see* Migratory Ants.
Drones, 299
Ducks, Cabocla duck, Dendrocygna discolor. Its relative, the Marreca-apahy, D. viduata, has a white head and black neck. In Southern Brazil and the Argentine is found the pretty Blue-winged Duck, Querquedula cyanoptera. 119
Dung-beetles. Most of the Scarabaeidae of Brazil belong to the genus Phanaeus, 287

Eciton, *see* Migratory Ants.
Eclectus pectoralis, New Guinea parrot, 215

Edentata, 168–9
Eel, 116–17
Egret, 164, 180
Eichhornia, belongs to the Pontederiaceae, and is related to the Liliaceae. Besides the Eichhornia crassipes described, the Agua-pé or "Water-foot," there is the Eichhornia azurea, with a blue inflorescence, and Pontederia cordata, known in Brazil as Mururé (Pl. 27, bottom, right). 42, 58, 118–19, 151
Elateridae, 228
Electric Eel, 175
Elephant-Beetle, Megasoma elephas, 176
"Elephant-Louse," 41
Emerald Bee, *see* Euglossa.
Emerald Snake, Cobra verde, Philodryas aestiva, Shotti, Olwersi. Burnished Snake, Oxybelis fulgidus, 343
Endosperm, 39
Engenhos, 145, 150
Entada scandens, 97
"Enxada," cultivation by, 145
Epiphytes, 100–12
Espigo de Sangue (Balanophoraceae), to which the Lophophytum mirabile belongs, whose spadices, according to Warburg, may reach a weight of 30 lb. In Helosis guyanensis the spadices are borne on steles. Langsdorffia hypogaea has antler-shaped stems in the bast of the host, and flowers like those of certain thistles. 111
Espirito Santo, 31, 114
Eucalyptus. There are 160 species, mostly natives of Australia (Myrtaceae), 155–7, 366
Euglossa cordata and smaragdina, a Bee with long proboscis: *see* W. A. Schulz, *Allg. Zeitschr. für Entomologie*, 1901. 295
Euphorbia pulcherrima, *see* Parrot-Flower.
Euphorbias, 67–8, 120, 121, 134, 237–8

Facheiro, *see* Cacti.
Fan-palms. These are the palms with fan-shaped leaves. A certain Banana-plant, whose leaves are gathered into a fan-shaped crown, is also called a Fan-palm in Brazil: Ravenala madagascariensis.
Farinha, 142–3
Favelliera, Pachystroma acanthophyllum, a Euphorbia, 124
Fazendas, 129, 145–57
Feijoada, 142
Ferns, climbing, 91
Ferreiro. 1. Araponga (Procnias nudicollis). 2. Turucuhé (Synallaxis ruficapilla) and the larger Phacelodomus rufifrons (Pl. 28, 22 and 20). 3. Hammer-frog (Hyla faber). 126, 130, 187–8, 251, 270, 271
Field-wasp, Polistes; for example, P. versicolor, 292–3
Fig, fertilisation of, *see* Fig-wasp.
Fig-cactus, 126, 242
Fig-tree, Ficus (Moraceae), 101, 243–4
Fig-wasp, Blastophaga brasiliensis, for seven Brazilian figs. They belong to the Chalcididae, 243–4
Filaria, Filaria Bancrofti, a threadworm, 354
Finches, 257
"Finger of God," Dedo do Deus, 72

Fire-eye, Papa Taoca (Taoca = Driver Ant), (Pl. 28, Fig. 23), Pyriglena leucoptera and atra (Formicariidae), 196, 314
Fireflies, 227–9
Fish, 175–6, 274–6
Flame Acacia or Flamboyant (Poinciana regia) from Madagascar (Leguminosae), 24, 132
Flat-headed Catfish, Aspraedo laevis, 276
Fleabane, Meladinha Hyptis, of which there are 300 species in Brazil (Labiatiae); the kind common in Olinda is, according to Hoehne, a Ruellia (Acanthaceae), 97, 151, 240
Flesh-eating Plants, 108
Flies, 227
Flies, among Driver Ants. The species described is Ecitomyia Wheeleri. The "Ant-head Fly" is Apocephalus, 316
Flor de quaresma = Lent-flower, 71
Flower-clock, a, 239
Flowers, 230 *et seq.*
Fly-flower = Aristolochia.
Flying-fish (Exocoetus volitans). Its pursuer is a Tunny, Thynnus pelamys, in colour a splendid steely blue, with an iridescent shimmer of red and green, which the Brazilians call the Bonito (simply "the Beautiful"). This great fish pursues its prey with vigorous leaps, and often catches it in the air, 45
Forest twilight. Dr. E. Snethlage speaks of the green twilight of the Amazon forest, but she is presumably contrasting the forest with the sunlit steppe. I cannot think that the Amazon forest, consisting likewise of sparsely-foliaged trees, would differ greatly in this respect from that of North-eastern Brazil. 72–3
Forest, virgin, 63–87
  at Kubany. *Goeppert, Skizzen zur Kenntnis der Urwälder Schlesiens*, etc. (*Nova Acta*, Leop. Acad. 1868). Wessely estimates that decay occurs in 150–200 years. The best authority on forests is K. Rubner, *Die pflanzengeographischen Grundlagen des Waldbaus*, Neudamm, 1925. 68–9, 75
Forked Fern, Gleichenia linearis, with 30 species, generally distributed throughout all warm regions, 74
Fox, Raposa or Aguarachain Canis (Pseudalopex) azarae, 127, 178
Foxes, 127
Frango d'agua, *see* Waterhen, Hyacinthine.
Freycinetia, 99
Frigate-bird or João grande, Alcatraz (Fregata aquila); in Brazil usually Fregata minor, 49
Frogs, 259–60, 270
Frutta pão, *see* Breadfruit.
Fungi in nests of Leafcutting Ants, *see* Sauvas.

Gadflies, Motucas, Tabanus importunus, leucaspis, triangulum, mexicanus, Erephopsis leucopogon, Dicladocera, 285, 350–1
Gaivoto = Seagull.
Gallo da Campina, Cardinal finch (Paroaria gularis), 125, 130
Gall-Wasps, 243–4
Gamba, *see* Marsupials.
Gamelleira, *see* Tree-Strangler.
Gannet, Atoba or Mergulhão (Sula leucogaster), 49
Gaturamo, Euphonia violacea, 257

Gecko, *see* Vibora.
Genipapa, Genipa americana (Rubiaceae), 139
Gesneriaceae, 102
Giant Ant, Dinoponera grandis, 323
Giant Bean, Entada scandens; in Brazil, Entada polystacha (Leguminosae), 97
Giant Beetle (Buprestid), Euchroma gigantea, 86
Giant Fly, Motuca (Acanthomera picta) and a Giant Hawk-fly (Midas), 227
Giant Owl-moth, Erebus agrippina, 226
Giant Toad, Bufo maximus and marinus, 260
Giboia, Cobra do veado (Boa constrictor), 164, 339–42
Glyptodon, 169
Goatfoot Bindweed, Ipomaea pes caprae. Creeping over the sand, and sinking roots at intervals, it attains a length of more than 100 feet. The Sweet Potato belongs to this group of plants (Convolvulaceae). 43
Goeldi's Frog, Hyla Goeldii, 272–3
Golden Butterfly, Diona moneta. The species in which the underside of the wings is pure gold in colour is Argopteron aureipennis, 207
Golden Rain, Brazilian, Cassia silvestris (Leguminosae), 131
Golden Wasps, in Brazil Chrysis sexdentata and others, 292
Gourds, Maxixe, Cucumis anguria, a spiny (native) gherkin, the size of a plum, eaten cooked; Pepino (Cucumis sativa) from Asia, Abobora (Cucurbita pepo) in many varieties; a favourite kind has red pulp. 144
Gramma convallaria, 133
Grapefruit, Citrus hystrix, var. decumana; the fruit is often as large as a man's head, 139
Grapes, 146
Grass, known in Brazil by the Indian name of Capim. In the tropics there are many species of grass, but they do not play so important a part as with us, and do not so greatly affect the character of the landscape. But the Campos, the steppes, in dry regions and in the south of Brazil, are naturally covered with grass; we find the Aristida family, Cortaderia (Gynerium), Selloana, Gynerium saccharoides, the "Uva grass," Bouteloua racemosa, and the Andropogon or Beard-grass. The following species are valued as fodder: Panicum monostachyum, Stenotaphrum glabrum, Sporobolus indicus, which also yields a straw for hat-making; Bromus unioloides, Leptochloa virgata, Melinis minutiflora and others. Also a species of wild barley (Pariana). 133
Grasshopper, *see* Locustidae.
Graúna, Aaptus chopi, 256
Gravatá, *see* Bromelia.
Gravatá frog, Brachycephalus ephippium, 107
Greenlet, Virio, Pachysilvia and Cyclorhis, stands between the Flycatchers and the Shrikes (Virionidae), 226
Greybeard, Tillandria usneoides (Bromeliaceae), 102, 109–10
Grison vittatus, 178
Gryptotherium, 169
Guanabara Bay, 32, 35
Guanco, "Rain-tree," Pithecolobium saman (Leguminosae), 365
Guapuvuru, Schizolobium excelsum (Leguminosae), 136
Guaraná, Paullinia cupana (Sapindaceae). The seed is extremely rich in caffein. 147
Guariba = Howler Monkey.
Guayave, guava, Psidium guayava (Myrtaceae), 140

Guinea-pigs, wild, Preyá Cavea aperea; the Mocó (Cerodon spixi) is rather larger. The Rock Cavy is Cerodon rupestris. 173, 197, 201
Gurundi, Tachyphonus coronatus, 256

Haberlandt. *Eine botanische Tropenreise*. Leipzig, 1910, 67
Hammer Frog, *see* Ferreiro.
Harpalyce (Galegeae), Butterfly-flower, 97
Hawkmoths, 164, 234–5, 240
Hawkweed, Hieracium (Compositae), 156
Hectorides, 216–17
Hedgehog-fish, 46
Hedge-sparrow, *see* Carrixa.
Heliconidae, 86, 191, 218–220
Hercules Beetle, Dynastes Hercules, 176, 278
Herons. Brazil boasts of a large number of magnificent herons. The Socó is Ardea cocoi, the Socó-y, Ardetta erythromelas; Garça azul, Florida coerulea. The Silver Heron or Egret (Garça real) has been terribly persecuted in South America, in order that women may decorate their hats with its feathers or aigrettes. A few dealers are enriched, a number of women wear, for a short time, what they believe to be an adornment, and a living creature of dazzling loveliness is destroyed for ever. In the more sparsely inhabited regions of Brazil the following herons are found: the Night Herons (Taquiry), Nycticorax tayazuguira, the Bittern, Reed-drummer or Socóboi, so called from its roaring, bull-like voice (Tigrisoma lineatum), and the curious Boat-billed Heron (Cancroma cochlearia). The family of the Storks is also well represented: for example, by the Tuyú-yú (Tantulus loculator) and the Jabirú (Mycteria mycteria) with black head and rosy collar, but otherwise white. The Brazilian Stork (Cegonha) is like our German Stork, but larger (Euxenura magoary). The Red Ibis of the Amazon is one of the loveliest birds on earth. 58, 119, 180
Herzog, Th., *Vom Urwald zu den Gletschern des Cordillere*, Stuttgart, 1923. 90
Heteropteris, in 100 varieties; Malpighiaceae, 98
Hibiscus, 131
Hippa, a Crayfish, like the River Crayfish, but red, 159
Histeridae, Beetles, living with Driver Ants, for example, Xylostega colligii, 315
Hoatzin, or Agana, Opisthocomus hoazin, 175
Hoehne, *A Flora de Brazil Rio*, 77
Hokko or Mutúm, Crax carunculata, Mitua mitu and others, 175, 186
Honey, 234, 298
Honey-ant, Cryptocerus elongatus, 301
Honey Wasp, Nectarina mellifica. And, according to Ducke, Polybia occidentalis stores honey in unfavourable weather. 294
Hookworm and Hookworm Disease, 353–4
Hornets. The large Black "Cavallo do cãe" is Pepsis albomaculata; P. pertys is even larger. Sphex ingens is another very large hornet. 126, 284–6
Hortensia (Hydrangea opuloides), Saxifragaceae, 134
Howler Monkey, Coata; Ateles paniscus, geoffroyi and other species, 174, 211–12
Hudú, Momotus momota, a fine gaily-coloured bird, in form resembling our Magpie, but with a toothed bill. Another species (M. microstephanus) has a peculiar habit of sitting quite still, but the long tail-feathers, blue and green, and rimmed with black, move constantly to and fro, about once every second, so that it is pertinently called "the Pendulum Bird," Passaro pendulo. 196

Humming-Birds, 98, 135, 161, 180, 183, 206, 235, 237, 261
"Hyacinth," Alophia, an Iris, 240
Hyacinthine Waterhen, Frango d'agua verde e azul, Porphyriola Martinica, 118–19
Hylaea (Rubiaceae), 98

Ibis, Red, Guarú, Eudocimus ruber, 208
Iça, Sauva queen, 309–11
Ichneumons. The small black wasps which prey on the Rosy Caterpillar are Apantheles balthazari and Parisierola nigrifemur. The larger wasps were Bracon pinus. Larger forms are Ophion and other Braconidae, and Crypton macrocereus. The entomologist Costa Lima of Rio has published many details concerning these wasps, mostly in the *Archivos da Escola superior de Agriculima e Medicina veterinaria. See* vol. iii, 1919. 153, 282–3
Idaeus, butterfly, Papilio idaeus, 280
Iguana or Chamelõa, Iguana tuberculata, 59, 86
Ihering, *see* Bees, and Animal Geography, also 162, 167
Imbauba, Chandelier-tree or Ant-tree, Imbauba branca, Cecropia hololeuca; Imbauba do brejo, Cecr. lyratiloba, 318
Imbuia, a species of Tecoma, 77
Imhambú, Tinamus tao, Crypturus and Odonthophorus in the forest; in the steppe, the "Partridge" (Rhynchotus rufescens), 175, 186, 213–14
Indians, the, 369–70
Ingá, Inga marginata, cinnamomea and others, 77
Ipé, Tecomaipé, Ipe amarello, yellow-wood, Tecoma lapacho (Bignoniaceae), 77
Intimidation, 221
Ipomaea floribunda. The Ipomaeae have magnificent flowers, and are cultivated in hot-houses and elsewhere as "Morning Glories" (Convolvulaceae), 97
Irara, Galictis barbara, 178
Iris or Sword-lily, 74, 199
Ironwood, 68
Ita line of steamships, 29

Jabiru, Mycteria mycteria, 136
Jaboticaba, Myrciaria (also Eugenia) jaboticaba and cauliflora (Myrtaceae), 79
Jaca, Arctocarpus integrifolia, from Upper India (Moraceae), 79, 138
Jacamar, Guamunbi, Galbula rufoviridis, 186, 206, 215
Jacarandá, in several species: brasiliana, caroba, cuspidifolia, mimosaefolia (these two are also called Caróba); yields the dark Jacarandá- or Palisander-wood (from Pau santo, "holy wood") for furniture and piano-cases. The same name, however, is given to the wood of the Leguminosae, Machaerium and Dalbergia, which are known as Jacarandá preto (Dalbergia nigra) and Jacarandá-tree (Machaerium allemani), 81, 92
Jacaré, *see* Caiman.
Jacú, Penelope jacucaca, superciliaris and others, 175, 186
Jacytára, Desmoncus polyacanthus; another species, D. horridus (Palmae), 92, 93
Jaguar, Onça pintada (Felis onza), 128, 177–8, 203
Jahú, 148
Jambo and Jambolão, Eugenia jambos and jambolana (myrtaceae), 80, 132
Jandáya, Conurus jendaya, with yellow head and throat, red belly, green back and long tail, and Conurus cactorum, with green back, yellow belly and bluish wings; also Eupsittacula aurea, 125

Jangada, 23
Japú, Ostinops decumanus, 256
Jararaca, *see* Snakes, Venomous, 128, 347
Jassana, or Piaçoca, Jaççana jaççana, 119
Jatobá, Hymenaea courbaril, 68, 77
João do barro, 161
Joanninha, a fish, Crenicichla lepidota and others; the name is also given to a Cockchafer, 274
Joazeiro, Zizyphus joazeiro (Rhamnaceae), 124
Jucá, Cassalpina ferrea, var. cearensis (Leguminosae), 124
Jurubeba, Solarum paniculatum (Solanaceae), grows profusely on waste land and scree, like our Nightshade.

Kaki fig, Diospyros Kaki, from Eastern Asia (Ebenaceae), 138
Kapok-tree, 79
Keel-tailed Lizard, Tropidurus hispidus, 41
Kerner von Marilaun, *Pflanzenleben*, 3rd ed., by A. Hansen. 3 vols. Leipzig, 1921.
Kingfisher, Great, 59, 119, 215
Kinkajou, 178
Knight Butterflies, Papilio, a group with strikingly beautiful forms, 216

Laburnum, 131
Lagarta rosada = Rosy caterpillar.
Lantern-beetles, Vagar lume or Pyrilampos (Lampyrinae). In America there are more forms than in all the rest of the world together; as long ago as 1870 450 species were known. At Rio, Photuris lumifera is common. The Cucujo, the large lantern-beetle, one of the Elateridae, is Pyrophorus noctilucus. The luminous larva and the female with the glowing red head and thorax and the 10 pairs of blue or yellow luminous spots are Phengodes (Hieronymi). The male of this beetle (Telephoridae) flies. The "Lantern-bearer," Fulgora laternaria and lucifera, in Brazilian a gitiranaboia, belongs to the Hemiptera. 227–9
Larvae, 226
Laurel, 77
"Leaf-bloomers," Phyllanthus speciosus and other species. Phyllanthus nobilis is known in Brazil as Perola vegetal. The Phyllanthi belong to the Euphorbiaceae. 238
Leaf-bugs, 278
Leaf-butterflies, Anaea phantes, with blue, Siderone Ide with red-striped, Siderone Clara with yellow upper surface. Also Coenophlebia Archidona mimics a leaf with the under-wings, which show, when the wings are closed, leaf-stalk and midrib, 22–6
Leafcutting Ants, *see* Sauva.
Leaf-locusts, Pterochroza. The species with brown wings is P. colorata; with green, P. cristata; with green, and withered tips, P. arrosa; with eyes on the hind-wings, P. ocellata. 223–4
Leguan, 59, 86
Leguminosae, 78, 81, 366
Lemonade, 140
Lemons. The small round lemon of the Tropics is the Limonelle, Citrus medica, var. acida, usually called the Lime. Its juice is exported to Europe. 139-40

Lent-flower = Flor de queresma.
Lepidoptera, 217, 225
Liana Snake, Cobra cipó, Herptodryas carinata, 203, 343
Lianas, Cipó or Trepadeira, climbing plants. The classic work on Lianas is Schenck's *Beiträge zur Biologie und Anatomie der Lianen*, in *Botanische Mitteilungen aus den Tropen*, Vol. V, Jena, 1892. 88–99
Lime, *see* Lemons.
Lion Monkeys, Leontocebus rosalia, 174
Liszt Monkey, *see* Oedipus Monkey.
Locustidae. Grasshopper, Gafanhoto. The large forms are Tropidacris cristata and Tr. grandis. Migratory Locusts, Schistocerca paranensis. The wingless larvae are known as Hoppers (Saltões), and they too migrate, devastating the country, 223–4, 261
Lontra or Ariranha = Otter (Pteronura braziliensis), sometimes over 6 feet in length, 178, 181
Loro = Monk-parrot.
Louro, various Lauraceae of the Ocotea and Nectandra families, 77
Love-lilies, or Agapanto, Agapanthus umbellatus, from South Africa (Liliaceae), 135
Luminous Beetles, *see* Lantern-beetles.
Lung-fish, Lepidosiren paradoxus, 275
Lutz, Dr., 270
Lycenidae, 158

Macacheira, 143
Macaiba-palm, Acroconia intumescens (Palmae). The fruit looks like a crab-apple, and tastes of egg; it is not very good eating, and has a hard kernel, 42
Maçambira, Bromelia, 121
Macaws, 175, 193, 213
Maceió, 29
Macrosila cluentius, a moth with long proboscis, 234
Madras Bulbul, Pycnonotus haemorrhous, 155
Magnolia (Magnoliaceae), 80
Mahogany. The best wood is furnished by Swietenia mahogani from the Antilles (Meliaceae). 77
Maize, Milho, Zea mais. Probably came from Mexico. From maize meal Maicena and Mondamin are made. 145
Malaria, 348–9
Malarial mosquito, Anopheles of various species, 348–9
Mamangaba, *see* Lobster.
Mamangaba (Bee), 295–6
Mamão, *see* Tree-melon.
Manatee, Ox-fish, Lamantin, Peixe boi, Trichechus inunguis in the Amazon, manatus on the coast; but the latter sometimes enters the rivers, 193–4
Mancinella-tree, Hippomane m., Euphorbiaceae, 124
Mandarin, Tangerine, Citrus nobilis, 139
Mango-tree, Mangifera indica from India (Anacardiaceae), 79, 82–3, 137
Mangrove. In Brazil two families of these trees occur, Cassipomea and Rhizophora. Rh. mangle is the most frequent species. 57–8, 82
Maniçoba, Manihot Glaziovii (Euphorbiaceae), 68

Manioc, Manihot utilissima, the poisonous species, which has to be roasted, and Manihot dulcis or aipi, the non-poisonous species. The starch of the manioc-tubers is the tapioca of commerce, the starch-grains being coagulated by heat (Euphorbiaceae). 142–3

Mantis, Louva deos, many species (Mantidae), 224

Mantis-flies, Mantispa. In Wasps' nests Symphrasis myrapetrella is reared, 224, 281

Maparajuba, Mimusops maparajuba (Sapotaceae), 139

Maple, Acer platanoides (Aceraceae), 117

Mara, Dolichotis patagonica, 173

Marsupial Frog, Nototrema oviferum, pygmaeum, 273

Marsupials. The largest forms are the Mucura, the Timbú or Gambá, in the Argentine known as Comadreja (Didelphis aurita, marsupialis and paraguayensis). Smaller forms are the Quicas or Chichicas (Metachirus and Caluromys), while the Catitas (Marmosa pusilla and Perammys domestica) look like shrew-mice. The Water-opossum is the Cuica d'agua (Chironnectes minimus). 167–9

Martin-fishers, related to our Kingfishers: Br. Martim pescador or Ariramba. The large Martin-fisher is Ceryle torquata; the smaller species are C. amazona, ovida, americana, aenea. 59

Maruim, Pinus or Polvora, Simulium, 350

Massaranduba, Mimusops. M. do rio, Mimusops alata; M. do Pará, M. Huberi; M. do Ceará, M. rufela, M. verdadeira, Vitullaria procera (Sapotaceae). 77

Maté, Ilex paraguayensis (Aquifoliaceae), 146–7

Megatherium, 169

Melastomaceae, 320

Melocactus, 117, 126

Metamorphosis, 91

Methone, 218

Migratory Ants, Formiga de correicão or Taoca, Eciton family (Dorylinae). The largest is Eciton rapax; Eciton legionis attacks Camponotus; Eciton hamatum and Eciton Burchelli are the real Driver Ants; the latter is the species which I observed. Concerning their guests, *see* Flies, Staphylinidae, Ichneumons, Histeridae, and Ants, and the literature relating thereto.—The first to describe them were Bates, *The Naturalist on the River Amazon*, and Belt, *The Naturalist in Nicaragua*, London, 1874. 312–18, 334

Migratory Locusts, *see* Locustidae.

Mimeciton, 318

Mimicry, 218 *et seq.*

Mimosa, 81, 155–6, 239

Mistletoe (Loranthaceae), 110

Monk Parrot, Loro or Catorra (Myiopsitta monachus), 187

Monkeys, 173–5

Monocotyledons, 84

Monsoon, 24

Monstera deliciosa or Philodendron pertusum. The fruit, reminding one of a pineapple, but full of small spines, is eaten as "Banana do brejo." 80, 90, 93

Morenas, 371

Morpho, 181, 191, 193, 207, 216

Morpho Bahiana. The Morphidae, with their blue, lustrous wings, as large as a man's hand, are perhaps the loveliest butterflies in the world. 59, 216

Mosquitoes, 348–9

Motúca, a Gadfly, Lepidoselaga crassipes. The Hornet which paralyses it and feeds its larvae upon it is Monedula signata. 285, 350–1
Mulungu, Erythrina mulungú and reticulata (Leguminosae), 132
Multiplication, 184, 293
Mummer-Beetle, Erotylus histrio; mimicked by Poecilopeplus corallifer, 221
Mussurana, Rhachidelus brasili, 192, 345
Muturus, 216
Myasis, 351

Nandidae: Polycentrus Schomburgki, 275
Natural life, protection of, 181–2
Nectar, 234
"Nectar-flowers," 234
Neotropinae, 217
Nephila clavipes, a large greenish-white Spider, 208
Nettle, Jatropha urens (Euphorbiaceae), 42
Nictheroy, 34, 36, 46
Nightjars, 213–14
Nillu, Strobilanthes pulcherrimus (Acanthaceae), 82
Nine-o'clock Bindweed, Turnera, nearly related to the Violaceae; Turnera ulmifolia is found all over South America, 43
Nova Friburgo, 85, 108, 133–4
Nove horas = Nine-o'clock Bindweed.
Nutria, Swamp-beaver, Myocaster coypus, 172
Nuts, coco-, 38–9; Brazil-, 77

Ocelot or Leopard-Cat (Felis pardalis). There are also the similar Long-tailed Cat (F. Wiedi) and the Tiger-Cat (F. Tigrina). 178
Oedipus Monkey, Leontocebus oedipus, 211
Oil palm, Dendê (Elaeis guienensis). The fruit-cluster, in its spathe, looks like a basket full of orange-yellow plums, and may weigh as much as a hundredweight. The principal distribution of this palm is in Africa; as a source of vegetable oil its importance is constantly increasing. Warburg inclines to think that its original home was America. 42
Oiticica, Pleragina umbrosissima, 124
Oititiroba, Vitellaria or Lucuma revicoa, also Peróba branco (Sapotaceae).
Oity, Moquilea tomentosa (Rosaceae), 366
Olinda, 21, 26, 54, 112, 201, 207, 212, 240, 350, 354, 356
Ombú, Phytolacca dioica (Phytolaccaceae), 79, 241
Oncidium (Orchids), 105
Operculate Snail, 272
Orange (Citrus aurantium) probably comes from China. First brought to Portugal in the sixteenth century; then to Italy. 139
Orchid-mould. S. Decker recommends, for growing orchids in pots, a mixture of the roots of Polypodium or Osmunda, and sphagnum moss in equal parts, a lump of charcoal the size of a hazelnut, and a little leaf-mould. 104–5
Orchids, 102–6, 132, 234–5, 241–2
Organ Mountains, 36, 160
Organism, Nature as an, 183
Organists, Euphoniidae, 256
Oriole, Crested, 59
Otter, *see* Lontra.
Owl Moth, 226

Paca, Agouti paca, 173, 197, 201, 203
Pachiuba palm, Iriartea exorrhiza (Palmae), 84, 136
Painted Lady, 164
Palisander = Jacarandá.
Palm-beetle, Rhynchophorus palmarum, 279
Palm-lily, *see* Yucca.
Palms, 79, 83–4, 134, 366
Palm-wasp, Pseudochartergus, 293
Palmito, 84
  jussará, Euterpe edulis (Palmae), 142
Palmyra palm, 79
  growth of, 84
  climbing, 91
Pandanus, 99
Papa capim, Sporophila coerulescens, 257
Papagaio, *see* Parrot-bush.
Papaja, *see* Tree-Melon.
Para Nuts, *see* Brazil-nut tree.
Para Rubber-tree, *see* Seringueira.
Parahyba, 358
Parasites, 100–12
Parasol Acacia, 366
Parasol Fig, Arvore parasole, Ficus Roxburghii (Moraceae), 79
Parasol Wasp, Apoica pallida, 293
Parrot-bush, Euphorbia (Poinsettia) pulcherrima (Euphorbiaceae), 134, 237
Parrot-fish, Balistes vertula, Trigger-fish, or Catapult-fish, so called because it spits out water, and is thereby able to bring down insects perched on twigs above the water. By means of a dorsal spine (the trigger) the fish is able to fix itself in the crevices of the rocks. The name of Parrot-fish is given also to certain fish with hard beaks, the Scaridae, which are splendidly arrayed in blue and white and red. They are mostly good eating. 47
Parrots, 123, 136, 208, 215, 268
Partridge, Perdiz, Rhynchotus rufescens (Tinamidae), 186
Passion-flower, Maracujá, Passiflora coerulea, alata, edulis and other species. Passiflora quadrangularis has splendid red flowers and fruits as large as melons, which are good eating. The 300 species of Passion-flower are mostly native in America; a few species are native in Polynesia. 42, 98, 140, 231
"Pasteboard Ants," Camponotus, Aztece, Dolichoderus, 320
"Pasteboard Wasps," 293–4
Paternoster Pea (Abrus precatorius), in all tropical countries (Leguminosae), 42
Pau Brazil = Brazil-wood.
Pau d'alho, Galexia gorazema (Phytolaccaceae).
Pau d'arco, Tecoma heptaphylla. Pau d'arco means Bow-wood; the tough wood is used for making bows, 70, 93
Pau de ferro, *see* Ironwood.
Pau de Jangada, Apeiba tibourbou, belongs to the Lindens (Tiliaceae), 23
Peacock Moth, 236
Peccary, two species, the Collared Peccary or Catete (Pecari tajacu), and the White-bearded Peccary or Queixada (Tayassu pecari), 177, 267
Penguins, 49–51
Pepper, 142
Perandro, 279

Periquito, parrakeets. In São Paulo, Brotogerys titica. The smaller Sparrow Parrakeet, Psittacula passerina, 136
Pernambuco, 21, 23, 40, 86–7, 97, 103, 249, 258–60, 305
Pernambuco-wood = Brazil-wood.
Peróba, about 30 species of the family Aspidospermum (Apocyanaceae).
Peste de cadeiras = Gadfly.
Petropolis, 85, 133, 366
Petropolis Frog, Hylodes petropolitanus, 272
Phanaeus, 183, 202
Phylloxera, 152–3, 155
Phytocrene lianas, 90
Picuda, Sphyrena picuda, 48
Pieridae, 217
Pigeons. In the Sertão, Rolinha cascavel (Scardafella squamosa) and the larger Pomba do Sertão (Zenaida auriculata). On the coast, and in the gardens, are many doves and pigeons, among them the charming rosy-brown Pigmy Dove, Chamaepelia passerina, Rola pequena. The larger pigeons are called Jurity. 125
Pigmy Frog, Hyella tenera and minuta, 271
Pill-wasps or Mud-wasps; in Brazil, for example, Eumenes canaliculata, 291–2
Pinho, Araucaria brasiliensis, *see also* Anona (Pinaceae), 139
Pintasilgo, Spinus ictericus, 257
Pipa, Pipa americana and cururu, 273–4
Pipridae or Manaquims, among them the Rendeira (Pipra rubrocapilla), Velho (P. leucocilla), Uirapuru (Chiroxiphia pareola), 214, 216, 303
Piranha, Pygocentrus piraya, 175
Pitanga, Eugenia uniflora; also E. edulis and others (Myrtaceae), 138
Plane, *see* Maple Plant-lice, 278
Plover, Massaricao, Numenius hudsonicus and Aegialitis collaris. The black and white peewit is Himantopus brasiliensis and mexicanus, 50, 118
Pollen, 231 *et seq.*, 241–2
Pollen-flowers, 234
Pollinia, 242–3
Polygala, 199
Polyphagous species, 192
Posoqueria (Rubiaceae). P. acutifolia, Bacopary miuda, P. calantha, Araça do brejo; P. latifolia, Açucena do matto; R. fragrans, 243
Potter-bird, João de barro, in the Argentine Horneiro, Oven-builder, Furnarius rufus; in the North-east, F. figulus; in Amazonas, F. tricolor. 161, 188, 251
Potter-wasps, Trypoxylon albitarsius and Sceliphron fistulare, 285
Prepona, 217
Preyá, *see* Guinea-pig.
Primavera or Sempre lustrosa, Bougainvillea spectabilis with bright red, B. glabra with deep wine-red blooms (Nyctaginaceae), 93, 98
Protective coloration, 213 *et seq.*, 225–6
Puma, 177–8
Puma or Silver Lion, Onça, Ounce (Felis concolor), 127
Pupae, of ants, 305
Pyrostegia (Bignoniaceae), 98
Pyrrhalina filamentosa, 275–6

Quail, Cadorna, Nothura maculosa (Tinamidae), 186
Quebracho branco, Aspidospermum quebracho blanco (Apocyanaceae).

Quebra foice, Calliandra axillaris and Tweedii (Leguminosae), 239
Quiabo, Hibiscus esculentus (Malvaceae), in India, Bandaca, in North America, Okra; in English, Lady's-finger, or Bamia, in French Gombo, 142

Rabo de Rato, *see* Whip Cactus.
Raccoon or Maopelada, in S. America the Crab Raccoon (Procyon cancrivorous), so called because it eats crabs, 178
Rat's-tail, *see* Whip Cactus.
Rattan, Calamus rotang (Palmae), 89, 92
Rattle Butterfly, Ageronia arethe, black with blue markings, and white cross-bands; A. arethusa with white borders, 261
Rattle-frog, 259
Rattlesnake, *see* Snakes, Venomous, 128, 203, 345, 347–8
Recife, 21, 22, 26, 155, 209, 266, 364
Red soil, 200
Redbeak, Bico vermelho, Patativa, Sporophila leucoptera hypoleuca, 257
Relogio = Nine-o'clock Bindweed.
Resin-Frog, Hyla resinifictrix, 273
Rhea, Ema, Nhandu, Rhea macrorhynca, 127
Rice, Arroz, Oryza sativa, a plant of ancient cultivation, mentioned 2700 B.C.; with 1,400 sub-species, among them some that can be grown on dry soil, such as the so-called Mountain Rice, 145
Ricinus, Castor-oil plant, R. communis (Euphorbiaceae), 156
Ringed Plover, Massarico, Aegialitis collaris, 118
Rio de Janeiro, 24, 32–7, 247–9, 356–7
Rodents, Roedores, Rodentia, 161, 171–3, 200
Roedeer, *see* Deer.
Rolinha, *see* Pigeon.
Rompe gibão, Bumelia sertorum (Sapotaceae).
Root-climbers, 93
Rosa de madeira, 110
Roses, 131
Rosy Caterpillar, Gelechia gossypiella (Tineidae), 152–3, 155, 191, 196
Rosy Hibiscus, H. rosa sinensis (Malvaceae), 131
Rubber-tree, 243
Rupicola, Cock-of-the-Rock, 208, 263

Sabiá, Sabiá una, Platycichla flavipes, Sabiá branco, Turdus amaurochalinus, Sabiá laranjeira, Turdus rufiventris. There is also a grey "Mocking-bird," Sabiá da Praia, Mimus lividus. 254–5
Saguim or Silk-monkey, Callithrix iacchus, 41, 86, 137, 174, 266–7
Sahy or Sugar-bird, Cyanerpes cyaneus (Coerebidae), is one of the most beautiful birds on earth (Pl. 28, 1). It is a deep blue, with a light-blue cap, and satin-yellow on the wings. 180, 257
Saint Francis's Girdle, Cordão de São Francisco, Leonotis nepetifolia (Labiatae).
Sand-bees, 126
Sand-crab, Ocypoda arenaria, 43, 54–6
Sand-flea, Bicho de pé, Jigger (Dermatophilus penetrans), 351–2
Sand-wasps, 126
Sanhaçus, Tanagers. The light-blue Sanhaçu is Tanagra cyanoptera (also episcopus). The yellow Sanhaçu is Calospiza flava, the Coconut Sanhaçu Tanagra palmarum. The Rainbow Tanager (Sete cõres) is Calospiza tricolor. 136, 180, 206, 213, 257

Santos, 33, 53

São Paulo, 23, 24, 149, 200, 364, 356, 367

Sapo, Toad, 260

Sapoty, Achras sapoto from Central America (Sapotaceae), 139

Sapucaja, Lecythis pisonis; Sap. branca or mirim, Lec. lanceolata (Lecythidaceae), 77

Sarásará, red-legged, Camponatus rufipes, 321

Sauva, Leafcutting Ant; in Brazil the commonest species is Atta sexdens. Smaller species are Acromyrmex niger, subterraneus, etc. The fungus cultivated is Rhozites gongylophora. The chief authorities on the life of the Atta are Bates, Belt (*see* Migratory Ants), A. Möller, *Die Pilzgärten einiger südamerikanischer Ameisen*, Jena, 1893; Von Ihering, *Berl. Ent. Zeitschrift*, 1895, etc.; and J. Huber, *Biol. Zentralbl.*, 1905. 126, 191, 196, 303–312, 321, 331

Sauva's Guests, the. The Carabid beetle which I discovered, Coeloxenus Guentheri, belongs to the Orthogoniinae, which was already known to furnish certain inhabitants of termitaries. The Rhinoceros beetle is Coelosis sylvanus; the Cockroach riding on the backs of ants is Attaphila Bergi (parasitic on Acromyrmex Lundi). Among the Staphylinidae there are Cordylapsis tuberculata, Plociopterus atticida, and at the entrance to nests, Glenus biplagiatus. For literature, *see* Ants, Staphylinidae, 307–8

Scarabaeidae. Dung-beetles, mostly with horns or antlers, which form pellets or balls of dung in which they lay their eggs. The large brilliant forms belong to the Phanaeus family. 183, 202–3, 206–7

Scarlet Tanager, Tié-fogo, Pipira (Rhamphocoelus brasilius), 212

Scissors-bird, Muscivora tyrannus, 195–6

Seagulls, 50

Seal fishery, 50

Sea-bladder, *see* Caravella.

Sea-lion (Otaria byronia), 49

Sea-urchins, 159.

Sebito, Certhiola or Coereba chloropyga, a small brown bird with grey throat and yellow belly, 153, 196, 257

Seitz, *Die Grossschmetterlinge der Erde*, Vol. V. *Die amerikanischen Tagfalter*, Stuttgart, 1922, 158

Self-fertilization, 232

Semfim, Sacy, Peitica, Tapera naevia, 258

Sensitive Plant, *see* Mimosa.

Seriéma, Cariama cristata, 127, 136

Seringueira, Rubber-tree (Hevea brasiliensis), also called Arvore da borrache, 243

Serrador, Volatinia jacarini, 120

Sertão, the, 113–30

Serum, anti-snakebite, 348

Sesostris, Papilio Sesostris, especially well represented in the Amazon basin, 216

Seven-hued Tanager, *see* Sanhaçus.

Sharks, Tubarão. According to Alipio de Miranda Ribeiro (*Zoologia Brasilica*, S. Paulo) the dangerous Sharks are the Tintureira (Galeocerdo maculatus) and the Annequin (Carcharodon carcharias), which grow to a length of 32 feet. Less dangerous is Carcharias lamia. The Shark is usually accompanied by the Pilot-fish (Naucrates ductor), a small striped fish, which swims before the Shark, in order to warn the latter of the presence of its prey. 47–8

Shrimp = Camarão, 47

Silk-cotton Tree, Bombax malabarica, also Chorisia speziosa, Paina da seda; in the Argentine known as Samohú. The true Kapok tree is Ceiba pentandra (Bombaceae), 79
Silk-weeds or Milk-weeds (Asclepiadeae), 242
Silver Monkey, 212
Singing-birds, 253
Siriri, Tyrannus melancholicus, 250
Skunk, Cangambá, Surilho (Conepatus chilensis), 178, 192
Sleeper, Dorminhoco, Bucco maculatus. In São Paulo, Bucco chacuru. Belongs to the Bearded Cuckoos or Sloth-birds (Bucconidae), 125, 215
Slender Frog, Paludicola gracilis, 271
Sloth, Preguiça. Two species: the widely distributed Ai (Bradypus tridactylus), and in the North the Unau (Choloepus didactylus), which has only 2 toes on the forefoot, and only 7 cervical vertebrae; another species has only 6. 136, 169–171, 319
Sloth-bird, Dorminhoco (Bucco), *see* Sleeper.
Sloth-moth, Bradypodicola Hahneli, a Pyralid, 278
Snail, Operculate, Caramujo, Ampullaria striata and caniculata. A snail with a long trumpet-like shell, as big as a man's fist, which is met on damp paths, is Bulimus ovatus. There are many other species. 272
Snakes, green, *see* Emerald Snakes.
  non-venomous. Xenodon Meremii, Neuwiedi, Guentheri, Helicops angulatus, 339
  venomous. Besides the Coral-snakes (Elaps corallinus and frontalis) there are the following venomous snakes in Brazil: Surucucú or Surucucú pico da jaca (Lachesis muta), Jararaca, Jararacucú (Lachesis lanceolata), Labaria, Jararaca (Lachesis atrox), Urutú, Cruzeiro (Lachesis alternata), Jararaca do rabo branco (Lachesis Neuwiedi), Cotiarinha, Furta-cór (Lachesis itapetiningue), Urutu dourado, Surucucu tapête (Lachesis jararacucú), Cascavel, Rattlesnake (Crotalus terrificus), 128, 175, 221, 337–348
"Soap-cassia." Lavo prato, Cassia medica, said to yield lather for washing dishes (Leguminosae), 98
Socó, 119
Soffrer, 125, 256
Soldado, 256
Solitary Bees, Tetralonia bifasciata; a larger bee, Centris collaris; there are many others.
Sparrow, European (Passer domesticus), 247–8
Specific Markings (Species recognition-marks), 216
Spiders, 207–8, 284–5
Spores, 306
Spurges, *see* Euphorbias.
Squirrel, Cachinguelé, Guerlinguetus aestuans, 173
Stamens, 231
Stanhopea (Orchids), 104
Staphylinidae, 307, 316–17, 335
Starling (Icteridae), 247–8, 253–6
  Indian, Acridotheres melanosternus, 250
Stick-insect, Phasmos. Proscopia punctata and other species. The Stinking Stick-insect is Phasma putridum, 224
Stigma, 231
Strategus aloeus (beetle), 279
Sucurú, João bobo (Bucco chacuru), a Sloth-bird, 186

Sucury, Anaconda (Eunectes morinus), 339, 342

Sugar-cane, Canna de assucar, Saccharum officinarum (Gramineae), probably derived from India, where it is still more largely cultivated than elsewhere (excepting Cuba). There are various species; one is known as Canna patriotica or Canna federal, as the cane is striped with green and yellow, the colours of the Brazilian flag. 115, 150–1

Sugar-Cicadae. Silvestri was the first to observe Cupira Bees (Melipona pallida) sucking the larvae of a Cicada (Aethalion reticulatum). But one may see the Irapuan doing likewise, and I have also caught the Urussú in the act. 301

Sugar-beetle, Besouro da canna, Podalgus humilis and Ligyrus fossator (Scarabaeidae), 287–8

Sugarloaf, The, 34–7, 160

Sumaúma (Ceiba pentandra, also Eriodendron anfractuosum). Belongs to the Bombaceae or Silk-cotton trees. The capsules contain a fine downy cotton, known commercially as Kapok, and which is so light that it is especially adapted to the filling of lifebelts. 79

Surucua (Trogon viridis), a bird with brilliant red, blue, green and yellow plumage, and a toothed bill, 206

Surucuru, 347

Swallows, Andorinha; the most frequent are Panyptila cayennensis and Diplochelidon cyanoleucus, 189

Swallowtail butterfly, Papilio thoas brasiliensis, 192, 216, 237

Swamp-crab, *see* Crabs.

Sweet Potato, *see* Batata doce.

Sword-beetle, a Dung beetle, Phanaeus ensifer, 287

Symbiosis, 105

Syntermites, in Sauva nest. According to Wasmann the insect I found is probably a new species, Syntermes inquilinus, 334–5

Syphilis, 353

Syrinx, 253

Tacuaré = Climbing Bamboo, 91

Talipot Palm, Corypha umbraculifera, 116

Tamanduá, *see* Anteater.

Tambaqui (Hoplosoma), one of the Characinidae, with palatable flesh. Occurs in the Amazon, 194

Tanagers, *see* Sanhaçus.

Taoca, *see* Migratory Ants.

Tapir, Anta, Tapirus terrestris, 165, 177, 267

Tartaruga, *see* Tortoises.

Tatayba, Firewood, Chlorophora tinctoria (Moraceae).

Tatú, *see* Armadillos.

Tea (Chá da India), Thea sinensis (Theaceae) from Eastern Asia, 146

Teju or Lagarto, Tupinambis teguixin, 214

Temperature, 64–5

Tendrils, 94–6

Teque-teque, Todirostrum poliocephalum (Tyrannidae), 187

Termites, Cupim. Nils Holmgren, in his study of the South American termites (*Zool. Jahrbücher, Systematik*, 1906), gives 55 Brazilian species. The different species are most readily distinguished by their nests. Calotermes (canellae, rugosus) makes mere tunnels in trees. Anoplotermes makes galleries and chambers in the soil. Of the earthen nests, according to Heyer, the "ant-hills" of the large termites (Cornitermes cumulans and similis) consist of loam; those of the medium-sized termite (Eutermes fulviceps) of loam and earth, those of the small termites (Anoplotermes ater and morio) only of earth. Anoplotermes turricola builds a turret-like nest. Eutermes Rippertii, rotundiceps, chaquimayensis and others build paper nests on trees. Fungi are cultivated in the "hills" of the very common Termes dirus. Termes saliens and riograndensis, like the Ant, Odontomachus, are able to leap backwards on snapping their mandibles. For a comprehensive account of the life of the Termites, *see* K. Escherich, *Die Termiten*, Leipzig, 1909. 165, 325–36

Termite-guests, Solenopsis Edwardi, a thieving Ant; also Brachymyrmex and Monomorium. With Eutermes fulviceps lives the harmless Ant Crematogaster alegrensis. Camponotus personatus and termitarius defend the termitary. The Beetle which resembled a winged sexual Termite is Atractocerus termiticola. Of Staphylinidae with defensive forms there are Termitopsenius and Eupsenius. Timeparthenus is the Staphylinid with the bloated abdomen; the Fly described is Termitomastus leptoproctus; it lives with Anoplotermes reconditus. For literature, *see* Termites and Ants. 335–6

Tern, Trintareis, Sea-swallow, 50

Terra roxa, 200

Tertiary Period and Deposits, 165–6, 176

Teu-teu, *see* Plover.

Therezopolis, 85, 133

Thoas Butterfly, *see* Swallowtail.

Thorn-Cicadae (Membracidae). A two-spined form of Hemiptycha punctata and Umbolca spinosa, 225

Thorny Spider, Gasteracantha Kochi, broader than it is long, and bears large double spikes on the hinder part of the body, 208

Thrush, *see* Sabia.

Thunbergia = Azure Convolvulus, 98

Thyme (Labiatae), 120

Thynnus Wasp, Thynnus cornulus, São Paulo. This group does not occur in Europe. 281

Ticks, Ixodes, Haemaphysalis, Amblyoma humerale, Margaropus microplus, Ornithodorus talage and rostratus (Carrapato do Chão), 351

Ticotico, Brachyspiza capensis or Zonotrichia pileata (Fringillidae), 166, 248

Tiger-cat, *see* Ocelot.

Tiger-Orchid, Stanhopea tigrina, 241

Tijuca, 24, 85, 87

Timbú, *see* Marsupials, 168

Tirucalli, Euphorbia tirucalli, from Africa. In Brazil there are hedges of Euphorbia, known as Avoloz. They are common in the interior, near Caruarú. 238

Tortoise, *see* Turtles and Tortoises.

Tortoise Beetles. These beetles (Cassidinae) belong to the Leaf-beetles (Chrysomelidae), which in Europe also have golden-green representatives. The species described as covering its offspring is Omoplata pallidipennis. A metallic-green Brazilian species (Desmonota variolosa) is often set in gold or silver, like a gem, 203

Toucan, 175, 215

Tovaca, Chamaeza brevicauda (Formicariidae), 258

Toxodon, 172

Tree-cactus, *see* Cactus.

Tree-climbing frogs, Dendrobates trivitatus and tinctorius. The poisonous exudation of the latter is used by the Indians in their arrow-poison.

Tree-creepers, Dendrocolaptidae, 161

Tree-ferns, in Brazil the species Alsophila taenitis, plagiopteris and phalerata, 85

Tree-frogs, 270–3

Tree-melon, Mamão (in English, Papaw or Pawpaw), Carica papaya, probably from Mexico, but now distributed throughout the Tropics, as it grows readily from seeds, 140–1, 213, 241

Tree-porcupine, Coëndu villosus and prehensibilis, 173

Tree-stranglers. For the Tree-strangling Figs the section Urostigma has been established, but they still bear their old name of Fig (Moraceae). The Brazilian Gamelleira is Ficus doliaria. There are also Tree-stranglers among the American Clusiaceae (Abano, Clusia fluminensis) belonging to the Guttiferae; some of them are epiphytes, which seems to point to the derivation of the stranglers from the Figs. Now, of course, the Clusia grows upwards from the ground. It first supports itself upon a tree, preferably a Palm, when an adhesive gum exudes from the wounded bark. The plant forms fleshy leaves, which are so heavy that they crush the shoots. These rub against and wound one another, adhere together, and finally coalesce, and as the process continues a trellis is formed, which grows closer and closer, and at last becomes a closed tube. Martius saw whole ranks of Macaiba-palms whose crowns emerged most strangely from the flower- and leaf-covered tubes in which they were imprisoned. This Clusia alba does not injure the palm, as a palm-tree does not increase in girth. 111–12

Trepadieras = Lianas.

Treub's works, in the *Annalen von Buitenzorg*, vol. 3 and elsewhere, 83

Trigger-fish, *see* Parrot-fish.

Trintareis, *see* Tern.

Trumpet-flower, creeper, Tecoma radicans (Bignoniaceae), 93

Tropical gardens, 131–44

Tropics, the, 64

Tubarão, a shark.

Tucunaré, Cichla temensis and ocellaris, 274

Turucuhé, Synallaxis ruficapilla, 187–8, 251

Tuyu-yú or Cabeça de pedra (Stone-head), Tantalus americana.

Turtles and Tortoises. In Brazil, Tartarugas. The most important of the Brazilian turtles is Podocnemys expansa, frequent in the Amazon, whose tender meat (tasting like veal) is a staple food. It is found also in Eastern Brazil. In the rivers and ponds of Central and Southern Brazil are the Kágados or Snake-necked Turtles (Hydromedusa tectifera) and other species. An amphibious Tortoise is the Aperema (Geoemyda punctularia); and a land-tortoise which lives chiefly in the forests is the Jaboty (Testudo tabulata). Of the marine turtles, the Suruaná or Scaly Turtle (Chelonia mydas) lays its eggs on the shore; other marine turtles are Chelonia imbricata or the Hawksbill Turtle (which yields the best tortoise-shell) and the Loggerhead (Caretta caretta). 47

Two-headed Snake, Cobra das duas cabeças, Amphisbaena, alba, really a lizard, 342

Tyrants, Tyrannidae, so called on account of their confident bearing, and because, like the Bemtevi, they give notice of anything that attracts their attention, and so seem to rule the whole neighbourhood. Among the Bemtevis are Pitangus sulphuratus Maximiliani, P. lictor (Bemtevi pequeno), Tyrannus melancholicus (Siriri) and Muscivora tyrannus (the Scissors-bird or Tesoura. with its forked tail), 161, 175, 187, 195

Underwings, 208
Ungulates, 167, 172
Urtiga do urubu, *see* Favelleira.
Urubú, Catharistes urubu. The species with the yellow head is Cathartes burrovianes, and that with the red head C. aura. The Urubú rei is Gypagus (Sarcorhampus) papa. 53–4, 190, 201, 216

Vaccinaceae, 102
Vampire. The bloodsucking Bats of Brazil belong to the Leaf-nosed Bats (Phyllostomidae). Desmodus rotundus and Diphylla ecaudata are genuine bloodsuckers, while the large Vampire (Vampirus spectrum), whose wings have a spread of 28 inches, has not yet been detected in sucking blood. 354–5
Vanilla, Vanilla planifolia (Orchids). The true Vanilla comes from Mexico. The family has many species in all tropical countries, 106, 146
Veado, Brocket, 267
Vegetable Springs, Phytocrene, large, hirsute lianas of Southern Asia, related to the Villaresiae of Brazil, whose leaves yield a substitute (Congonha) for Maté or Paraguay tea (Icacinaceae), 90
Venus'-hair Fern, Adiantum capillus Veneris. There are perhaps 80 species of Andiantum in the Tropics. In Europe they are employed in making up bouquets of flowers, or grown in grottoes, 135
Vibor, Gecko, Hemidactylus mabuia, a nocturnal lizard, 28, 343
Victoria, 32
  regia (Nymphaceae), 136, 239
Vine, Vinis vitifera, 146
Vira bosta, called also Corricho: Molothrus bonariensis. The Ringed Starling, Cassidix oryzivora, is likewise said to foist its eggs on other birds, 189
Viscacha, Visacia viscacia. The animal known to commerce as the Mountain Viscacha is the Legidium peruanum, 173
Vulture = Urubú.
Vulture-nettle, *see* Favelleira.

Wagtail, 187, 258
Wallace, 67
Warburg, *Die Pflanzenwelt*, Leipzig, 1913–22, 291–4
Wasps. *See* Hornets, Ichneumons. For a good summary, *see* A. Ducke, *Uber Phylogenie und Klassifikation der sozialen Wespen. Zool. Jahrbücher Systematik*, 1914.
Water-bugs, the large brown Belostoma, and Zaitha fluminea, 287
Water-cockroach, *see* Barata do mar.
"Water-fleas," 202
"Water-foot," *see* Eichhornia.
Waterhen, Gallinula galeata, 119
Water-louse, Water-cockroach, Rock-louse, *see* Barata do mar.
Water Marjoram, Brazilian, Eupatorium laevigatum (Compositae).
Water-opossum, 167
Water-weevil, Hydrotimetes natans, 280
Wax-plants, Flôr de cêra, Hoya carnosa, from India, so called because of its pretty wax-like flowers, 192
Weaver Ants, in Brazil Camponotus senex, observed by Goeldi; in India, Oecophylla smaragdina, 321

Wedge-nosed Bug, 351
Weevils, Curcullionidae. Brazil has many handsome species, especially in the genus Cyphus, 207
Whales: the commonest Brazilian species is Megaptera nodosa; more rarely, Balaena australis, 49
Whip-cactus, 106
Whistling Frogs, Leptodactylus typhonius. The large species about Rio is L. ocellatus. The male has monstrously thick arms. 259, 271
"White Ants," *see* Termites.
Wild Cats, Pampas Cat (Felis pajaros) in Rio Grande do Sul; also the Yaguarundi or Gato mouriscopreto (Felis yaguarundi) and the Eyra or Gatto vermelho (Felis eyra), 178
Wild Dog, Cachorrhinho do matto, Vinagre (Speothos venaticus). There is also a South American jackal, which the Indians succeed in taming: the Maikong (Canis thous), 178
Wild Swine, *see* Peccary.
Wolf, Lobo or Guará, Canis (Chrysocyon) jabatus, 178
Wolf-beetles, Lycinae. These beetles exude nauseating juices. The beetle mentioned is Calopteron bifasciatum; the mimics are Tropidosoma Spencii, the Capricorn, Lophonocerus hirticornis, and the butterfly Pionia lycoides, 220–1
Wolf Spider, Lycosa, 281
Wood-bee, Carpenter Bee, Xylocopa, some 30 species, 42, 295
Woodpecker, 195, 215, 319
Worker Bees, 299

Xarque, 142
Xenocephalus, 315
Xenodon, 343

Yellow fever, 348–350
Yucca, in various species; the finest, which the Brazilians call Cyrio da nossa Senhora, is the Gloria Palm-lily (Yucca gloriosa). The moth which fertilizes the Yuccas is Pronuba yuccasella, 244–6

Zaboticaba, 138

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